Printed on Thin Paper for Foreign Circulation.

The Engineer.

Established 1856.

Registered as a Newspaper.

OFFICE FOR ADVERTISEMENTS & PUBLICATION, 28, ESSEX ST., STRAND, LONDON, W.C. 2.

VOL. CLIV.—No. 3995] LONDON: FRIDAY EVENING, AUGUST 5, 1932 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES.

TO BUILDERS.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on (A) Tuesday, 23rd August, 1932, (B) Tuesday, 30th August, 1932, for LOW-PRESSURE HOT WATER HEATING at (A) Nelson-street Employment Exchange, Bristol; (B) General Post Office (South), E.C.

Drawings, specifications, copies of the conditions and forms of contract, bills of quantities, and forms for Tender may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Pound in each case. (Cheques payable to the Commissioners, H.M. Office of Works.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 8834

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R. C. MOORE,
Director of Education.

Education Offices,
Guildhall, Hull.
July, 1932. 8826

The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.
ARRANGED FOR CARD INDEXING.

Static Balance of a Shaft with Skew Stiffness. (P. 126)
(D. ROBERTSON, D.Sc.) THE ENGINEER, 5 - 8 - 32.

Economics of Urban Electric Railways No. III. (P. 127)
(HENRY WATSON.) THE ENGINEER, 5 - 8 - 32.

Aeroplane Launching Catapult. (P. 132)
THE ENGINEER, 5 - 8 - 32.

New Ocean Port for China. (P. 138)
THE ENGINEER, 5 - 8 - 32.

The Mechanical Design of Rotating Electrical Machinery. (P. 130)
(H. W. TAYLOR.) THE ENGINEER, 5 - 8 - 32.

Large Condensing Plant. (P. 140)
THE ENGINEER, 5 - 8 - 32.

Leicester and Swannington Railway Centenary. (P. 128)
THE ENGINEER, 5 - 8 - 32.

INDEX TO ADVERTISEMENTS, PAGE 47.

PUBLIC NOTICES.

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Registrar.

University College,
Cardiff.
July 19th, 1932. 8799

PUBLIC NOTICES.

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F. C. B. CHADWICK,
Clerk to the Council.

Town Hall, Seaton, Devon.
August, 1932. 8828

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SITUATIONS WANTED, Page 2.
AUCTIONS, Page 48.
PUBLIC NOTICE, Page 48.
MISCELLANEOUS, Page 2.
PATENTS, Page 48.
EDUCATIONAL, Page 2.
FOR HIRE, Page 48.
BUSINESSES and PREMISES (For Sale, etc.), Page 48.
FOR SALE, Pages 2 and 48.
PARTNERSHIPS, Page 2.
MACHINERY, &c., WANTED, Page 48.
AGENCIES, Page 2.
WORK WANTED, Page 2.

For Advertisement Rates see First Column Overleaf.

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A Seven-Day Journal

A New Reservoir.

LAST Thursday, July 28th, work on the construction of a large impounding reservoir was started at Talybont-on-Usk, Breconshire, for the Newport Corporation. Although the sources of Newport's water supply are still sufficient to meet the demand, it was decided to push forward the new construction work now rather than to wait until a later date when the new supply would be urgently required. This decision was made owing to the fact that the number of unemployed men in the district is very large. The work on the scheme is likely to continue for about five years and several hundred men will find employment on it. When completed, the reservoir will have an area of 323 acres and will be about two miles long. The storage capacity will be 2500 million gallons. The catchment area comprises approximately 5000 acres of the Brecon Beacons, the water draining into the Caerfanel, a tributary of the river Usk. A pipe line 34¼ miles long has been laid already, and a filter house and auxiliary works constructed. The water which will be obtained is of exceptional purity. The contract for the construction of the reservoir at a cost of £367,699 has been awarded to Mr. James McColville, of Abergavenny.

Drainage of the Severn and Avon Rivers.

A REPORT upon the state of the rivers within the jurisdiction of the River Severn Catchment Board was presented by the engineer, Mr. A. Barton, at a meeting of the Board held last Friday, July 29th. The report dealt largely with the causes of floods in the district. The weirs on the Severn and Avon were, it was stated, chiefly responsible. There were thirteen fixed weirs on the first-named river and twenty-six on the second. Although these weirs were necessary, they should, it was urged, in most cases be sluiced in order that a bigger discharge should be obtainable during floods. The Board would have to consider the advisability of abolishing them and installing automatic barrages which could be lifted during floods. As far as the Severn was concerned, the engineer recommended that a survey should be begun immediately to find out what the channels were capable of discharging. There was reason to believe that the new cut at Maise Moor Bridge, Gloucester, would do a great deal to increase the discharge of flood water. The general state of the rivers under the control of the Board was bad. Fallen trees, slips of the banks, reeds, rushes and weeds were preventing the discharge of the floods.

New Turbo-Generator Set for Brighton.

SUBJECT to an agreement with the Central Electricity Board, the Brighton Corporation has placed an order with C. A. Parsons and Co., Ltd., for a new 30,000-kW turbo-generator set with condensing plant. The set will consist of a tandem cylinder 3000 r.p.m. turbine designed to operate at 650 lb. pressure and at a temperature of 850 deg. Fah., and of a three-phase alternator generating 50-cycle current at a pressure of 8000 volts. Feed heating will be done in four stages. The need for this new machine is an indication of the rapid progress which the Brighton Corporation's Electricity Department is making, for as recently as November 13th of last year we recorded the installation of a new 15,000-kW set. Largely as the result of the new areas that have been added to the Borough and the prospect of supplying current to the Southern Railway for the operation of part of its London to Brighton line, the capacity of the Southwick power station is rapidly increasing. Since the station was opened in 1905 and took over the load of the less favourably situated station in North-road the turbine plant has been superseded by larger and more efficient plant, although a certain amount of the original boiler plant is still in operation. The new Parsons generating plant to be installed in the station will have a capacity considerably in excess of any of the existing sets and will work at a higher steam pressure and superheat.

International Congress on Commercial Education.

THE closing session of the International Congress on Commercial Education was held last Friday, July 29th, and by this time many of the delegates will have returned home. Sir Francis Goodenough, Chairman of the Organising Committee, stated recently that the Congress had been successful in many ways, but particularly in having demonstrated clearly the growing appreciation which was being shown in all countries, and especially in Great Britain, of the value and vital importance to business of education and training for business. The idea that the principles and practice of commerce could be satisfactorily acquired in haphazard fashion, could be "picked up" by a process of trial and error without specific and scientific education and training, was steadily, if perhaps too slowly, dying. There was growing in its place a clear realisation of the truth that the nation that did not value trained intelligence was doomed. He was very hopeful that, as a result of the Congress, a great impetus would be given to the work of the British Association for Commercial Education, whose programme was to work for the improvement of the education and training of the business leader (the creative and directing mind); of the business getter (the salesman pure and simple); and of the business recorder (the competent clerk and correspondent). That was a programme that should closely interest the employer, the parent, and the educationist. It would give opportunity of national service to all who were keen on the country's commercial welfare. He expressed the gratitude of the Congress to H.R.H. the Prince of Wales for the lead he had given once more in such service to the community, and said that, apart from its direct practical value to commerce and education, the Congress had undoubtedly been a real contribution to the cause of international goodwill.

Wireless Telephony for Ships.

SUBJECT to amendment in the light of the regulations adopted at the forthcoming International Radiotelegraphic Conference, the Board of Trade has issued a notice regarding the operating arrangements for the new wireless telephone service between the marine wireless stations round the coast of the British Isles and ships in home waters. The charge applicable to radiotelegrams exchanged between British coast stations and small ships of the trawler and coasting class is 3½d. per word, which includes the ship, coast station, and land charges. For watch-keeping purposes the eleven coast stations are divided into two groups, the first consisting of Cullercoats, Fishguard, Land's End, North Foreland, Portpatrick, and Wick; whilst the second group is composed of the Humber, Malin Head, Niton, Seaforth, and Valentia stations. Each coast station will keep radiotelephone watch daily during the four main periods of ten minutes' duration, which may be extended under local arrangements to meet traffic requirements. The four main periods for the two groups will begin at the following times:—First group, 01.30, 07.30, 11.30, and 17.30; and in the case of the second group, 01.00, 07.00, 11.00, and 17.00. These are the only periods notified in the International list for fixed and land stations, but additional periods will be arranged by coast stations to meet traffic requirements or local conditions. A note will be inserted in the international list indicating that additional watches will normally be kept, but these may be altered from time to time, and particulars can be ascertained from coast stations. The service areas of coast stations will remain undefined for the present. Each station will cover as far as possible the nearer half of the areas lying between itself and the two adjacent flank stations operating on the same fixed schedules. The aim of the coast stations will be to develop efficient service in their areas and not to afford less reliable service at longer ranges.

The Reorganisation of the Royal Mail Group.

A FURTHER step in the reorganisation of the Royal Mail group, referred to in our Journal note of November 13th, 1931, was taken on Saturday last, July 30th, when a new company, Royal Mail Lines, Ltd., with a nominal capital of £4,000,000, was registered at Somerset House, with the object of taking over and running all the ships belonging to the Royal Mail Steam Packet Company, Ltd., R.M.S.P. Meat Transports, Ltd., the Nelson Line, Ltd., and David McIver and Co., Ltd. The directors of the new company are Lord Essendon, the chairman of Furness, Withy and Co., Ltd.; Mr. W. C. Warwick, a director of Furness, Withy and Co., Ltd., the Houlder Line, Ltd., and other shipping companies; Mr. P. G. Mitchell, the general manager of the R.M.S.P. Company and a director of R.M.S.P. Meat Transports; Mr. C. C. Barber, also a director of these two companies; Mr. A. T. Woods, director and general manager of H. and W. Nelson, Ltd.; Mr. W. Lewis, general manager of the Pacific Steam Navigation Company, Ltd., and a director of MacAndrews and Co., Ltd., and R.M.S.P. Meat Transports, Ltd.; and Mr. J. M. Eddy, who is chairman of Argentine Lands and Industries, Ltd., and a director of several other important South American companies. The combined fleets of the four companies whose ships are to be taken over under the reorganisation scheme drawn up by the voting trustees, amount to fifty-two ships with a total tonnage of about 440,450 gross tons. They are stated to have a gross approximate value of £7,000,000. By unifying the four companies under one strong board of control, it is expected that substantial economies in running costs will be effected.

Rail and Road Traction in France.

THE Office Central du Rail et de la Route has arrived at a certain number of conclusions which it regards as a necessary basis for legislation affecting transport by road and rail in France. In the first place, it holds that the organisation of transport must be undertaken in the national interest and not in the particular interest of rail and road carriers, whose interests should be subordinated to those of the general population. The French railways must be freed from State servitude and allowed to adopt more flexible methods of working and to fix rates with a view to fair commercial competition, for which purpose a plan will have to be prepared for co-ordinating all the transport services. The State should continue to exercise a certain control over the railways for the sake of the guarantee it offers to them, but the railways ought to be relieved of the crushing charges now imposed upon them, and enabled to carry on their business in the same way as the road carriers. Traffic should be distributed according to the advantages offered by road or rail in the way of economy, rapidity, regularity, and safety. In cases in which road and rail offer the same advantages for traffic they should compete fairly under the same conditions, that is to say, their charges and obligations should remain similar, while the road traffic must be controlled in the interests of everyone concerned—drivers, customers, other road users, and ratepayers. The idea of the Office Central is that nothing should be done to check the development of road transport, but that the road carriers and the railway companies should be given equal opportunities to compete for business. This contention means that one should not be placed at a disadvantage in relation to the other in the way of high fiscal charges and restrictions, as is the case at present with the railways. The conclusion appears to be that the different methods of transport should be co-ordinated under one controlling body, which would see that the traffic was distributed in the most suitable manner, and that the railways received their fair share of the business in collaboration with road carriers who should work under the same conditions as themselves.

A Business Forecast.

IN a Journal note of May 6th we published an extract from the "F.B.I. Business Barometer" for the second quarter of the year. In the forecast for the third quarter of the year, just issued, it is stated that the conversion of the £2000 million 5 per cent. War Loan to a 3½ per cent. basis represents the first major step towards world recovery since the onset of the slump in 1929. The success of that operation is likely to mark a turning point in Britain's commercial position. Unfortunately, the forecast continues, as was the case last year when it was still possible to treat the present slump as a trade cycle depression, events outside this country are likely to continue to hold up recovery. As stressed in the forecast for the first quarter, the present depression has passed the stage when it is possible to look for a return to the position in 1929. The system of "international" trade then operating has collapsed beyond recall. Some of the participants in that system are saddled with debts which, partly as a result of the fall in world prices, they can never hope to meet. Their choice seems to lie between writing down and economic collapse with political breakdown as an additional possible complication. In the United States the policy of credit "reflation" is making industrial and commercial readjustment more difficult, and thus postponing still further the day of recovery. Summing up, the probabilities are that Great Britain's domestic trade will continue substantially unchanged, falling off in one direction being offset by improvement in another, as has been the case over the past year; abroad the situation is on the whole likely to grow worse before there can be any permanent improvement.

Improving the Output from British Ore Deposits.

PROPOSALS made with the object of increasing the outputs from British iron ore and tin mines are contained in the report issued on Tuesday last, August 2nd, by the Advisory Committee for the Metalliferous Mining and Quarrying Industry. Large supplies of iron ore in Northamptonshire, Lincolnshire, and Oxfordshire, says the report, are available for making pig iron, but the development of these fields, like the West Coast hematite fields, is hampered by high railway freight costs. The plan of widening and deepening the canal system of Northamptonshire is recommended as a means of developing the iron ore industry in that area. Royalty charges, it is stated, also require amendment, and the suggestion is put forward that Sec. 13 of the Mines Industry Act of 1926 should be extended to metalliferous mines. On the subject of the tin mines of Cornwall and Devon, the suggestion is made that the Mines Department should institute a comprehensive survey of the plans of adits in the area, while proposals are made for a drainage scheme in the Camborne–Redruth area, with a transport tunnel, the amalgamation of the mining interests in question being presupposed. Other suggestions include proposals for a new and more equitable method of taxation, encouragement by the Ministry of Transport in the use of suitable mine waste for road work, a geophysical survey of the Leadhills and Wanlockhead area, and the undertaking by the Department of Scientific and Industrial Research or other appropriate body of research work with a view to increasing the percentage of metal recoverable in dressing tin ore and of improving the commercial grades of British fluorspar and barytes.

Static Balance of a Shaft with Skew Stiffness.

By DAVID ROBERTSON, D.Sc., M.I.E.E.

(1) *Skew Flexural Stiffness of a Slotted Shaft.*—When a circular shaft is bent by a transverse load, the load is balanced by an elastic force lying in the plane of bending. The same thing is true for any other form of shaft so long as the second moment of the section about an axis drawn in its plane through its centroid is the same for all directions of that axis. But when the section has different second moments about its two principal axes, the elastic force is oblique to the plane of bending, except when that plane coincides with one of the principal axes. Such a shaft has "skew stiffness." Suppose that a single slot or hole is cut in a circular shaft to form a keyway, or for some other purpose. There is least stiffness when the slot lies in the plane of bending and a maximum stiffness when that plane is at right angles to the radius drawn to the slot.

In Fig. 1, P O P^1 and Q O Q^1 are the axes of maximum and minimum stiffness, the latter passing through the slot and making an angle θ with the plane of bending, whose trace is Y O Y^1. Let s be the area of the slot, r the radius to its centre, and I_s, I the second moment of the section about the neutral axis for the slotted and unslotted shaft respectively. Further, let the slot be small enough to permit us to neglect its second moment about an axis through its own centroid. Then

$$I_s = I - s r^2 \cos^2\theta = (I - \tfrac{1}{2} s r^2) - \tfrac{1}{2} s r^2 \cos 2\theta \quad 1.01$$

This consists of a constant term plus one which varies with the position of the slot relatively to the plane of bending, and we may write:

$$I_s \propto \omega_0^2 - \gamma^2 \cos 2\theta \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad 1.02$$

where

$$\gamma^2/\omega_0^2 = \tfrac{1}{2} s r^2/(I - \tfrac{1}{2} s r^2) = \tfrac{1}{2} s r^2/I \quad . \quad . \quad . \quad 1.03$$

Since the elastic force lying in the plane of bending is proportional to I_s, its upper and lower limits are proportional to $(\omega_0^2 \pm \gamma^2)$. But the elastic forces are also proportional to the deflection. Hence, for the component in the plane of bending when the transverse deflection is ρ we may write

$$f_t = (\omega_0^2 - \gamma^2 \cos 2\theta)\,\rho \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad 1.04$$

The stress in that portion of the section which is the image of the slot in the plane of bending has an unbalanced stress-moment which gives rise to a second elastic force at right angles to the plane of bending. This force is proportional to

$$s r^2 \sin\theta \cos\theta = \tfrac{1}{2} s r^2 \sin 2\theta \propto \gamma^2 \sin 2\theta \quad . \quad 1.05$$

and the corresponding elastic force, normal to the plane of bending, is

$$f_n = \gamma^2 \rho \sin 2\theta \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad 1.06$$

When considering the effect of the weight of the rotor, or of the inertia forces due to whirling, the equations are simplified if ω_0 and γ be so defined that f_t and f_n in the above equations are not the actual forces, but their amount per unit equivalent mass of the rotor, and in what follows we shall use the word "force" in that sense. When the mass is not concentrated, the equivalent mass is that which, when concentrated at the c.g., would give the same deflection of the c.g. as the actual mass. For gravitational effects, a uniform shaft supported at the ends has an equivalent mass concentrated at its centre of $\frac{5}{8}$ of its actual mass, but this figure does not also apply to whirling forces.

For a circular shaft with a single B.E.S. keyway extending along the whole length of the shaft, equation 1.03 gives a value of 5 to 6 per cent. for γ^2/ω_0^2, but its actual magnitude would be much smaller than this because of the contribution to the stiffness by the part fixed by the key, and because the keyway would not usually extend along the whole length of the shaft. Two slots diametrically opposite to one another would give the same result as a single slot equal to the sum of their areas.

The "direct" elastic force is $\omega_0^2 \rho$, the constant part of the tangential force, and lies directly opposite to the deflection. The other component combines with the normal force to give the "skew" elastic force $\gamma^2 \rho$, making an angle 2θ with the plane of bending—that is, the skew force lies along the image of the deflection in the axis of minimum stiffness. The direct and skew forces lie along the image of one another in the axis of maximum stiffness; they come together when the deflection lies in that axis, and opposite to one another when the deflection lies in the axis of minimum stiffness.

(2) *Shaft with Equally Spaced Slots.*—Let there be n equal slots, or holes, in the shaft, uniformly spaced with their centres at the radius r, and each having an area s; the angle between the plane of bending and the radius to the first slot is θ, and the interval between the slots is $2\pi/n$—see Fig. 2. Then,

$$I_s = I - s r^2 \{\cos^2\theta + \cos^2(\theta + 2\pi/n) + \ldots \cos^2(\theta + 2\pi(n-1)/n)\} \quad . \quad . \quad 2.01$$

$$= I - \tfrac{1}{2} s r^2 \{n + \cos 2\theta + \cos(2\theta + 4\pi/n) \ldots + \cos(2\theta + 4\pi(n-1)/n)\} \quad . \quad . \quad 2.02$$

The cosine terms may be represented by the projections of n equal radii placed $4\pi/n$ from one another; with two diametrically opposite slots, for which $n=2$, these radii point in the same direction and their resultant is twice one of them. In all other cases the radii are equally spaced and their resultant is zero. We, therefore, conclude that with any number, greater than 2, of equal slots uniformly spaced around the shaft, the stiffness is the same for all planes of bending. With irregular slotting, the reduction of moment must be worked out for each case. The resultant of the cosine terms may, or may not, vanish, but if it does not there will be one, and only one, axis of maximum stiffness with an axis of minimum stiffness at right angles to it.

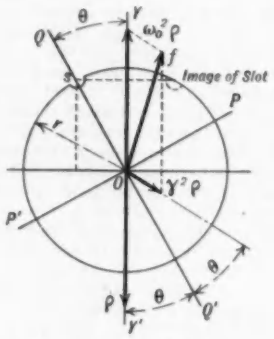


FIG. 1. SHAFT WITH ONE SLOT.

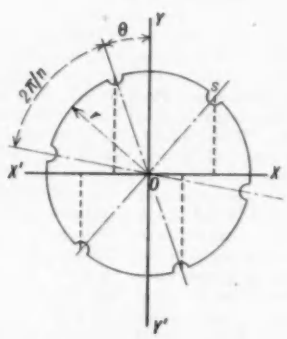


FIG. 2. SHAFT WITH UNIFORMLY SPACED EQUAL SLOTS.

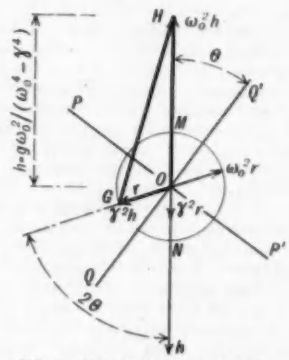


FIG. 3. GRAVITATIONAL DEFLECTION OF HORIZONTAL SHAFT WITH SKEW STIFFNESS.

"THE ENGINEER"

A shaft with two slots at right angles is equivalent to one with four equally spaced slots of half area, and, consequently, has no skew stiffness. Since skew stiffness above a certain small limit results in a range of speed throughout which the shaft is unstable in spite of friction, it is always desirable to arrange the keys on high-speed shafts so as to avoid it. A shaft which is not circular in section, such as a rectangular shaft, may have a considerable amount of skew stiffness. For instance, two diametrically opposite parallel flats cut along the length of a shaft so as to make the width across the flats three-quarters of the diameter give $\gamma^2/\omega_0^2 = 0{\cdot}24$. Such a shaft could not be run for more than a second or two at any speed between $(\omega_0^2 - \gamma^2)^{\frac{1}{2}}$ and $(\omega_0^2 + \gamma^2)^{\frac{1}{2}}$, or $0{\cdot}87\,\omega_0$ and $1{\cdot}11\,\omega_0$, nor, if it were long, at a speed close to $\frac{1}{2}\omega_0$. These speeds are dangerous in spite of friction even when the balance is perfect.

(3) *Gravitational Deflection of Horizontal Shaft with Skew Stiffness.*—With a horizontal shaft having skew stiffness, the static deflection due to the weight of the rotor, or other constant transverse force, varies between $g/(\omega_0^2 + \gamma^2)$ and $g/(\omega_0^2 - \gamma^2)$, according to the direction of the axes of stiffness. When the shaft is slowly rotated, the c.g. moves up and down between these limits, and it also has a to-and-fro motion in the horizontal direction. It runs as if it were out of truth, but a closer observation will reveal the fact that the wobble has twice the frequency of the shaft rotation. The mean of the extreme deflections is $g\,\omega_0^2/(\omega_0^4 - \gamma^4)$, whereas the deflection corresponding to the mean stiffness is g/ω_0^2.

In the diagram, Fig. 3, H is the position of the c.g. when the shaft is free from strain, M and N are at its highest and lowest positions when deflected by the weight, and G is the point of static equilibrium with the axes of stiffness in the directions shown. The deflection H G can be split up into two components H O ($=h$), vertically downwards, and O G ($=r$) along the image of O N in Q O Q′, the axis of minimum stiffness. The elastic force $\gamma^2 h$ will then lie along O G and $\gamma^2 r$ will be vertically downwards. The forces along O G are in equilibrium if

$$\omega_0^2 r = \gamma^2 h \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad 3.01$$

and the vertical forces will balance the weight if

$$g = \omega_0^2 h - \gamma^2 r = \{(\omega_0^4 - \gamma^4)/\gamma^2\}\, r \quad . \quad 3.02$$

whence $$r = \{\gamma_0^2/(\omega_0^4 - \gamma^4)\}\, g \quad . \quad . \quad . \quad . \quad 3.03$$

and $$h = \{\omega^2/(\omega_0^4 - \gamma^4)\}\, g \quad . \quad . \quad . \quad . \quad 3.04$$

Thus h is constant, equal to the mean of the extreme deflections, and consequently O is a fixed point midway between the highest and lowest positions of the c.g. Since r is also constant, when the shaft is turned round slowly, G must move in a circle whose radius is O G; O G must rotate twice as fast as the shaft, since it always lies along the image of the vertical in Q O Q′, which is fixed to the shaft. It is convenient to refer to this whirl with very slow rotation of the shaft as the "static whirl."

(4) *Static Balance by Rolling.*—In the ordinary method of static balancing, the shaft is laid across two parallel rails, whose tops lie in the same horizontal plane. The axis to which the static balance is tested is the centre line determined by the particular sections of the shaft at which it is supported by the rails. Care must therefore be taken to see that these sections are suitably located with respect to the bearings, and that they are free from defects. When the c.g. does not lie on this axis, the weight of the rotor makes the shaft roll until the c.g. gets as low as possible. The radial plane containing the c.g. is thus located and balance weights can be added on the opposite side and adjusted by trial until there is no tendency to roll away from any position.

The smallest amount of unbalance which can be detected in this way is limited by the resistance to rolling caused by the deformation of the rails and shaft at the points of support. The smaller that deformation, the more sensitive the arrangement will be. Kearton,[1] presumably referring to the rotors of steam turbines, quotes 1·1 mils as the limit of static balance attainable with cast iron "knife edges," and 0·4 mils with hardened steel ones. The rails are commonly described as "knife edges," because of a mistaken idea that the friction of a knife edge is less than that of other forms of support. By concentrating the pressure on a very small area, knife edges produce a maximum of deformation and they are consequently the very worst form the rails could have. The rails ought to be short polished circular bars of hardened steel ground truly circular and accurately straight, and they should have as large a diameter as is convenient. They should be supported throughout their whole length, preferably in vees so that they can be turned round to bring a fresh surface into play when desired. Because of the tilting of the shaft ends due to the weight of the rotor, flat-topped rails would only support the shaft at their edges. Their success consequently depends upon the truth of the edges, and they are equivalent to knife edges. Circular rails not only give greater sensitiveness, but they are also more easily made than knife edges of equal truth, and they are much less easily damaged. Moreover, should damage occur, a circular rail has only to be turned round through a small angle to make it as good as before, whereas an injured knife edge must be re-ground before it is of any service again.

Except when one of the principal axes is vertical, the weight of a horizontal rotor with skew stiffness deflects the c.g. to one side, and thereby causes a gravitational torque in addition to any that may be caused by want of balance. The eccentric torque pulls the c.g. towards the position where the eccentricity points vertically downwards, whereas the skew torque acts towards the nearer of the two positions in which the axis of minimum stiffness is vertical. There is no particular relationship between the positions of equilibrium under the skew torque, and under the eccentric torque, for the eccentricity may lie in any direction with respect to the axes of stiffness. The magnitudes of these torques are

$$\text{Skew torque, } \tau_s = M g r \sin 2\theta \quad . \quad . \quad . \quad 4.01$$

$$\text{Eccentric torque, } \tau_e = M g a \sin\theta' \quad . \quad . \quad 4.02$$

where θ is the angle between the axis of minimum stiffness and the vertical, and θ' that which the eccentricity makes with the vertical.

Fig. 4 shows how these torques vary with the angular position of the shaft. The eccentric torque goes through one cycle for each revolution of the shaft, but the skew torque goes through two. The phase relationship between the two will, of course, vary with the position of the c.g. relative to the axes of stiffness. We thus see that the skew torque interferes with the rolling test for static balance to such an extent as to render the test useless for detecting any excentricity much less than r. But, as we shall see, the difference between their frequencies enables us to separate them in a balancing machine.

(5) *Static Balancing Machines.*—If we measure the gravitational torque on an excentric rotor, instead of permitting it to cause rolling, we can determine both the radial position of the unbalance and its amount, and we thereby eliminate the trial and error method required by the rolling test. In essentials, a static balancing machine is an instrument for measuring this torque.

Fig. 5 shows diagrammatically how an ordinary chemical balance can be employed for this test with a light rotor. A vee hole is cut through the beam of the balance at any convenient distance from the centre, of a size suitable for carrying the shaft end, and at such a level that the centre of the shaft lies in the plane containing the knife edges. The other end of the shaft rests on a level rail so that the shaft is approximately horizontal and perpendicular to the beam. A small error in the level of the shaft in the beam is not of great importance, for its effect is

[1] W. J. Kearton, "Steam Turbine Theory and Practice," page 230 (Pitmans, London, 1931).

similar to an alteration of the height of the c.g. of the beam. It causes no direct error in the result, but does affect the sensibility. After the beam is balanced by weights in the right-hand pan, the shaft should be turned round in the vee, taking care to keep its endwise location always the same. If the rotor be in perfect balance, and there be no skew stiffness, the beam will remain in equilibrium for all angular positions of the shaft. But if the rotor be out of balance the gravitational torque will be transmitted to the beam through the friction of the vee, and the readings will vary accordingly with the angular position.

We may find the angular position which gives the maximum torque, $M g a$, and adjust the weights to equilibrium. The c.g. is now on the horizontal radius pointing outwards from the balance. Next

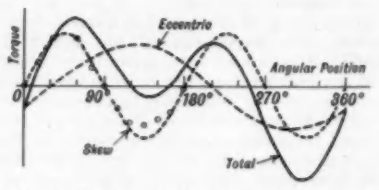


FIG. 4. ECCENTRIC AND SKEW GRAVITATIONAL TORQUES.

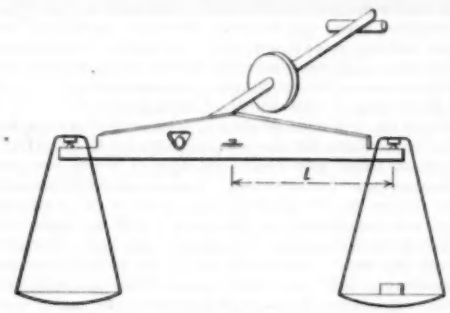


FIG. 5. MODEL OF STATIC BALANCING MACHINE.

turn the shaft through 180 deg., which reverses the maximum torque and will require minimum weights in the pan for equilibrium. The difference between the two balance readings multiplied by the distance between the central and right-hand knife edges thus gives $2 M g a$. Hence, if m be the difference in the pan weights, L the distance between the knife edges, m' the balance weight required to be fixed to the rotor at a radius r from the centre,

$$m' g r = M g a = \tfrac{1}{2} m g L \quad . \quad . \quad 5.01$$

or

$$m' = \tfrac{1}{2} (L/r) m \quad . \quad . \quad . \quad . \quad . \quad 5.02$$

As it is convenient to have screwed holes for receiving the balance weights prepared beforehand, when, of course, the position of the c.g. is not known, the following procedure is to be preferred to that given above. Four holes for balance weights should be provided on two axes at right angles to one another. Set the shaft in the machine with one of these axes vertical and adjust the weights for equilibrium. Now turn the shaft through 180 deg. and again adjust the weights. Equation 5.02 then gives the correct weight for the horizontal axis, to be inserted in the prepared hole which is next the balance when the higher pan reading was obtained. The test is then repeated with the other axis vertical in order to determine the other balance weight. Using this simple arrangement for a rotor weighing 300 grammes, it was found possible to detect an excentricity of about 0·2 mil. The shaft was a long one, which kept down the interference with the swing of the balance, and also the error due to variations of the endwise location in the two settings.

The arrangement just described is really a rough model of the Martin balancing machine.[2] In that machine, however, the free end of the shaft is carried on a suspended ball bearing instead of resting on rails. Because of the variation of the distance between the rail and beam supports with the swing of the beam and the friction opposing endwise movement of the shaft on the rail, our simple arrangement causes some constraint to the swinging of the beam and thereby reduces the sensibility; with a shorter shaft this loss of sensibility would have been more marked. The suspended bearing for the free end in the Martin machine avoids this trouble. In another form of balancing machine, made by W. and T. Avery, Ltd.,[3] the rotor is supported in two vees on a cradle which can swing on a pair of knife edges in line with one another and with the axis of the rotor. In this machine the torque is indicated by the movement of a pointer over a dial against a counterpoise attached to the bottom of the cradle.

When the shaft has skew stiffness the static balancing machine measures the resultant of the excentric and skew torques, but they can be separated because of their different behaviour as the shaft is turned round. A rotation of the shaft through 180 deg. reverses the excentric torque, but leaves the skew torque as it was. Consequently, any difference between the balance readings for these two positions is to be attributed to excentricity. The rotor may therefore be balanced separately along two orthogonal axes, as already explained. If the chosen axes for the balancing weights be the axes of stiffness, it is necessary to set the shaft very accurately in the desired positions, because these positions come at the zero points of the skew torque curve, where it is steep. An appreciable error arises from the setting being as little as 1 deg. out.

By choosing the axes of balancing at 45 deg. to the axes of stiffness, our selected points come on the level parts of the curve and the error caused by inaccurate setting is thereby reduced. This 45 deg. position should therefore be adopted when possible. Since the skew torque is there a maximum, the shaft may have to be clamped to prevent it slipping in the vees. There is no objection to doing so in the cradle type of machine, but in the beam type clamping is not permissible, for it would interfere with the free movement of the beam. Some sort of pointer and scale are required to indicate the angular position of the shaft; care must be taken to see that these do not introduce any unbalance.

The author has recently been carrying out a number of experiments on the whirling of shafts with the aid of a grant from the Colston Research Society. One of his models has a flatted shaft 250 mils in diameter and 185 mils across the flats. These figures give $\gamma^2/\omega_0^2 = 0{\cdot}24$, which agrees with the value deduced from measurements of the vibration frequency in the two principal planes. The total length is 36⅞in., with 35½in. between the bearing centres. Lengths of 2in. and 2½in. at the ends and of 1in. at the centre are left circular. The shaft itself has a mass of 203 grammes and it carries a disc of 64 grammes at its centre. The plotted points on Fig. 4 are the results of measurements made by the chemical balance on this model after it had been fairly accurately put into static balance by the method described. Slipping of the shaft made it impossible to obtain the 45 deg. reading and difficult to get some of the others. The static whirl was observed with this model and also the dangerous speeds mentioned.

(7) *Limitations of Static Balance.*—Static balance is only satisfactory when the form of the rotor is such that there is no serious risk of unbalance in one plane being corrected by an opposite unbalance in another plane some distance from it. Although it tells us the amount of the unbalance, and the radial plane in which that unbalance lies, a static test of any kind can give no information as to the location of the unbalance along the shaft.

Consider a shaft running in two bearings with a pulley or fly-wheel midway between them. The primary whirl, which reaches a maximum at the first critical speed, is a rotation of the c.g. around the axis about which the shaft itself would rotate if there were no whirl; the plane of the pulley and the line of the central portion of the shaft retain their original directions. This whirl is usually caused by static unbalance. At the second critical speed there is a conical whirl caused by the rotating couple exerted by the dynamic unbalance. The centre line of the shaft at the pulley traces out a cone and the plane of the pulley oscillates accordingly; there is no appreciable motion of the c.g.

It is sometimes stated that the primary whirl is not affected by dynamic unbalance,[4] but this is not quite correct. After the above rotor has been put into perfect balance let a disturbing mass be added *close to one bearing*. It will entirely upset the static balance of the rotor, but will scarcely produce any whirling when the shaft is run. Now, restore the static balance by adding a balance weight to the pulley. The rotor will now be found to whirl badly near the first critical speed, the whirl being almost identical with that obtained by adding the weight to the pulley without that at the end. In this extreme case improvement of the static balance has made the running balance very much worse. Keeping the static balance perfect, let the disturbing weight be moved along the shaft towards the pulley. It will then wipe out more and more of the whirl induced by the weight added to the pulley to balance it, and the balance will be perfect when it gets to the same plane as that weight. At the same time the couple causing the conical whirl near the second critical speed increases from nearly zero to a maximum when the weight gets about halfway to the pulley, and then diminishes again to zero when it gets to the pulley.

A STANDARD ball bearing of 15 mm. bore with standard ball cage can, according to the *Mechanical World*, be run at about 15,000 to 20,000 r.p.m., while one of 25 mm. bore cannot be expected to function satisfactorily above about 10,000 or 12,000 r.p.m. At these speeds lubrication must be carefully attended to.

[2] "The Martin Balancing Machine," *Engineering*, 110, pages 864–865, December 31st, 1920, and *Electrical Review*, 88, pages 101–102, January 28th, 1921; W. H. M. Martin, *Engineering*, 111, pages 195 and 334; B. P. Haigh, "The Static Balancing of Rotors," THE ENGINEER, 145, pages 310–312 and 338–340 (also page 350), March 23rd and 30th, 1928.

[3] H. N. Cox, "Balancing Turbine Rotors," *Engineering*, 111, pages 74–75, January 21st, 1921; also page 255. See also E. H. Lamb, "A Statical Balancing Machine," *Engineering*, 133, pages 641–642, May 27th, 1932, for another machine whose principle is similar.

[4] *e.g.*, Haigh, *loc. cit.*, page 312.

The Economics of Urban Electric Railways.

By HENRY WATSON.

No. III.*

SUBURBAN ELECTRIFICATION: PROBABILITIES OF REVENUE INCREASE.

IT has been shown in the last article of this series that an additional revenue of not more than 10 per cent. would generally cover the provision of a fast electric service, with a 50 per cent. increase of the midday or slack hour frequency, on a suburban route now passing thirty or more trains per day each way—see Fig. 5. Also that with 100 per cent. increase of train mileage, the revenue increase needed to meet the extra costs entailed, might be of the order of 25 per cent. with medium-frequency steam services, and 30 to 50 per cent. with high-frequency services. It remains to discuss the probabilities of traffic increasing considerably in response to improved facilities.

We may observe that an additional revenue of £1000 per mile of route annually demands 60,000 more passengers booking per mile of route per year at an average fare of 4d. If drawn entirely from season ticket holders, 100 more per mile would have to patronise the line than would otherwise have been the case. A railway 20 miles long must attract 1¼ million more passengers annually at this average fare.

Rate of Increase Required.—An adequate response of traffic or revenue to a considerable increase of facilities, implying a much more frequent service, must necessarily be of slow growth. This is particularly so where a very great increase of train mileage has been instituted. There may be an immediate accession of patronage from persons formerly travelling by alternative and less attractive means, and who appreciate the more frequent and faster service now provided. But improved receipts from persons taking up residence in the area served, and attracted thereto by the improved railway service, must be of slow growth. Thus the statement that an electrification scheme—just inaugurated with a substantial increase of train mileage—is making a satisfactory return on capital, can be true only over a long period, and presupposes a given and continuing rate of traffic increase. For some years there must be a deficit after meeting all charges and only on a long-time view can such be said to be satisfactory. Thereafter increasing profits

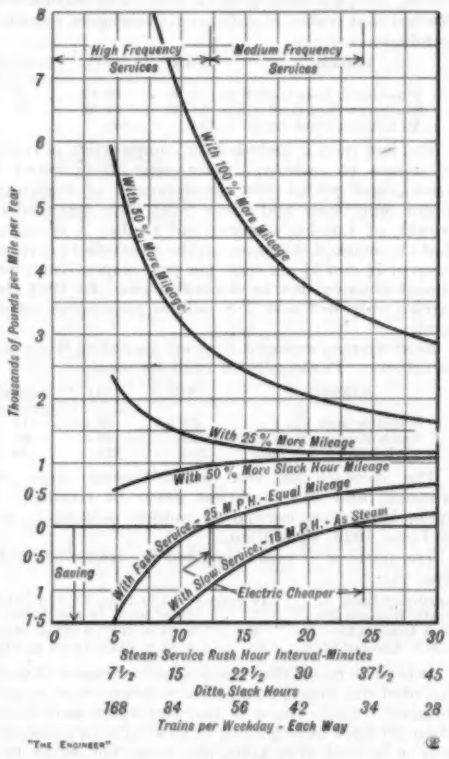


FIG. 4 (REPRODUCED)

will repay the losses of former years. When a 100 per cent. increase of train mileage is given, with the electric service—as has been the case on the Southern Railway—many years elapse before profits are forthcoming.

The question arises as to when the rising revenue should meet the extra costs, *i.e.*, how many years after electrification may be allowed to elapse before revenue "breaks even" with costs. It would seem fair to suggest that this should not exceed four years. Assuming a straight line increase of traffic—in arithmetical progression—it will not be until eight years after electrification that profits, over the bare interest charges, will be forthcoming. Indeed, it will be somewhat later, after allowing for interest charges on the withdrawals from reserves, which will be necessary if

* No. II. appeared July 29th.

dividends are to be maintained, when, say, 100 per cent. increase of train mileage is instituted within a few months. A proposal entailing any longer delay in waiting for returns would probably hardly interest a railway board seeking a profitable outlet for capital.

Thus, where a steam service with rush/slack intervals of 15/22½ minutes, or about fifty-six trains per day, is replaced by a 7½/11-minute electric one, with 112 per day, an increased revenue of £4700 per mile—see Fig. 4—or probably 30 per cent. of the entire revenue, would be needed—see Fig. 5. The revenue must increase by 7½ per cent. each year, *over what it would have been with a steam service*, before it can be said that traffic is answering satisfactorily

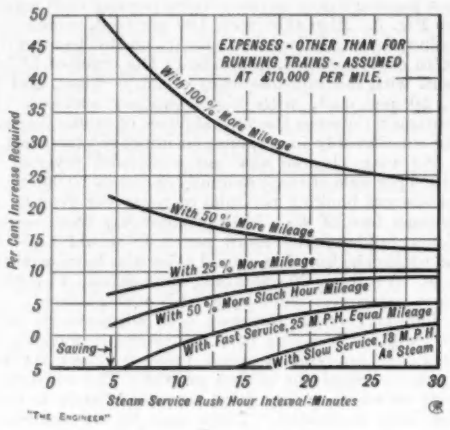

EXPENSES - OTHER THAN FOR RUNNING TRAINS - ASSUMED AT £10,000 PER MILE.
With 100 % More Mileage
With 50 % More Mileage
With 25 % More Mileage
With 50 % More Slack Hour Mileage
With Fast Service, 25 M.P.H. Equal Mileage
With Slow Service, 18 M.P.H. As Steam
Saving
Per Cent Increase Required
Steam Service Rush Hour Interval-Minutes
0 5 10 15 20 25 30
50 45 40 35 30 25 20 15 10 5 0 5
"The Engineer"

FIG. 5 (REPRODUCED)

to this marked increase of service. The italicised proviso is very important, and is discussed below.

Some Actual Rates of Revenue Increase.—Burtt's "Railway Electrification" gives some very valuable statistics of the total passengers on electrified suburban railways over various years, to which the writer has made frequent reference. We may first examine some pre-war examples of traffic growth on electrified lines, and take a period which was especially uneventful and stable, *i.e.*, 1908 to 1913. The electrification of the railways and local tramways—a serious competitor—had been effected some years before, and a steady growth had some significance. We find that traffic, in millions of passengers, increased as follows :—

Railway.	1908.	1913.	Increase, per cent.
Tynemouth lines (L.N.E.R.)	7·39	10·19	38
Southport lines (L.M.S.R.)	11·37	14·44	27
All London trunk lines	234	250	7

The last item is included for comparative purposes. It relates to railways, practically all operated by steam, and whilst the development of tramways, motor omnibuses and tubes must have retarded the growth of London's steam rail traffic, it is certain that the marked increases on the electrified provincial lines, of 7½ and 5½ per cent. per year respectively, were almost entirely due to electrification. In 1904 they carried only 6·2 and 7·8 million passengers respectively.

Next we may examine a period including war years, as follows. Passengers in millions were :—

Railway.	1913.	1918.	Increase, per cent.
Brighton lines	23·5	26·9	14
South-Western lines	25	40·4	61
All London trunk lines	250	325	30

The increase on the South-Western lines was amazing, and will doubtless never be rivalled. In June, 1916, they carried 2½ million passengers, and in June, 1920, 4¾ million.

The number of years required for traffic to double was :—

Southport lines	11 years	(7·81 in 1904, 15·5 in 1915)
South-Western lines	7 „	(25 in 1913, 52·6 in 1920)
East London line	9 „	(4·65 in 1907, 9·36 in 1916)
L.M.S. London lines	10 „	(6·98 in 1913, 15·08 in 1923)

It is to be noted that the marked increases of traffic included war years, when local railways were in great demand. Since the war the Southport and South-Western lines have held on to most of their gains, with only a limited drop from the boom figures of 1920, but the Brighton, or Central section of the Southern Railway, appears to have suffered badly since the war, partly owing to the electrification of the adjacent Eastern section, and partly to intense tramway competition. The Tyneside lines have also suffered badly since the war, but the London L.M.S. system has shown a marked increase of traffic in post-war years—from 13·2 in 1922 to 18·6 in 1927—which might well have had more attention than certain other post-war electrifications. A 41 per cent. increase in five difficult years is worthy of examination at length. This period, covering extensive expansion of omnibus services, yields the following results :—

	1922.	1927.	Per cent.
L.M.S. London lines	13·2	18·6	41 up
Southern Western lines	46·4	49·1	6 up
L.M.S. Southport lines	18·4	19·2	4 up
All London trunk lines	319	323	1 up
East London lines	11·4	10·2	10 down
Southern Central lines	28·3	22·1	22 down

The London trunk lines include the four main line companies, and the figures are as given by "London Statistics." Roughly half the total in 1927 was steam hauled.

The Southern Railway Results.—Particular interest attaches to the passenger figures of the Southern Railway electrified lines, because of their magnitude and the fact that this experience covers recent years when road competition has been especially severe. The writer has been informed by the company that the number of passengers conveyed between all stations in the electrified area in 1931 amounted to 218 million, showing an increase of 40 million, or approximately 22 per cent., over the traffic carried between the same stations in 1924. Thus the average rate of growth has been roughly 3 per cent. per year. The full benefit of 100 per cent. electrification has not, of course, obtained over all this period. Probably 45 per cent. of the 1924 traffic was electrically operated.

Now the important question is what would the figures have been with steam operation. To estimate this we may examine the total traffic figures for the London trunk or main line railways, as given in "London Statistics" for a number of years. Details of these totals are not obtainable. We may observe that the total number of passengers carried by the four main line companies in Greater London increased from 316 to 346 million from 1924 to 1929, or by 9 per cent. in five years. If we assume that 90 per cent. of the Southern Railway traffic on electrified lines passed in the London area, we obtain the proportions of these figures due to that company as $178 \times 0{\cdot}9 = 160$ and $218 \times 0{\cdot}9 = 196$ million passengers in 1924 and 1931 respectively. Assuming a uniform growth, the 1929 Southern proportion must be about 186 million passengers. Deducting, we have as the balance of traffic carried by other main line companies in London, mostly by steam trains, $316 - 160 = 156$ and $346 - 186 = 160$ million. This is a 2½ per cent. growth in seven years, against 22 per cent. on the Southern. These figures are obviously very approximate, but it seems a fair conclusion that on steam-operated lines the passenger totals have remained more or less stationary, and that the Southern traffic would have done likewise had that company adhered to steam traction. There is no reason to suppose that conditions are different on either side of the Thames as regards (1) road competition, (2) potentialities of housing development, or (3) extent of cheap fare facilities offered. Thus electrification may be credited with having yielded them a 3 to 4 per cent. annual increase of passenger traffic and revenue. The 3 per cent. increase of passengers will probably not have yielded a 3 per cent. increase of revenue, owing to the great increase in cheap fare facilities of late, but since that has had to be offered in any case, such may be claimed as due to electrification, *i.e.*, we may assume that the steam lines are retaining the same total of passengers, but with a declining total of revenue. This is suggested by the fact that the Southern revenue increased only £192,000 in 1930, with 12½ million more passengers, yet it increased by £213,000 in 1928 with only 6 million more passengers. This is according to statements at annual meetings. Passenger figures are not a reliable indication of revenue.

It has been stated that the train mileage under electrical operation has been nearly doubled. This statement is partly borne out by the increase in the number of trains arriving at London termini, as given in "London Statitsics." In consequence, the all-in operating costs of the Southern lines must have been increased by at least 25 per cent.—see Fig. 5. A 3 to 4 per cent. traffic gain per year therefore implies that any profits over 5 per cent. on capital are unlikely in less than twelve years. If less, then the rate of revenue increase must improve, or the electrification must be more economically worked than our estimates allow. The total number of trains entering Southern London termini has increased by 40 per cent. from 1913 to 1929, yet seven years have had to elapse in order to increase the total passengers by 22 per cent. It appears that the average annual increase of passengers is of the order of 6 million. The increases have been :—1927 over 1925, 7½ million ; 1928 over 1927, 6 million ; 1930 over 1929, 12½ million.

In 1931 20·6 million electric train-miles were run over some 280 route miles of track. This gives a train every 11 minutes in each direction on an average route, or 100 per day of 18 hours. If only fifty steam ones were operated, an increased revenue of about £4000 per mile of route per year is required—see Fig. 4. Thus a total increase of £1,120,000 is demanded. It has been stated that revenue increased by £192,000 from 1929 to 1930, and also by £213,000 from 1927 to 1928. As before, we find six years' growth is necessary before operating costs are equalled. This ignores the fact that there are 3½ track miles per mile of route, which increases the cost slightly over a two-track line.

The conclusion is unavoidable that the public response to the greatly improved facilities provided by the Southern Railway, taken as a whole over all its electrified network, is poor and disappointing. Revenue is increasing only very slowly, for so large an increase of train mileage, and the experience of this company is not so encouraging to other railways as is commonly supposed. Many statements in respect of it will not bear examination. It has been reported that receipts at eighteen stations between 9 and 14 miles radius have increased 50 per cent. in four years. But this ring excludes the gigantic inner suburban network, and itself appears to include over fifty stations. The statement therefore has little value. It has been said that traffic on the Southern steam lines has decreased, but this does not prove anything as regards London suburban steam lines serving rapidly growing suburbs. Traffic on the Eastern section increased by 15 per cent. in three years—from 51·5 to 59·3 million from 1924 to 1927, but that on the adjacent Central section fell from 28·4 to 22·1 million, largely cancelling the gain.

General.—The general lesson here seems to be that a substantial increase of revenue to cover a bold scheme involving a widespread network of lines, subject to intense road competition by omnibus, coach, and tram, in both outer and inner suburbs, can be obtained only over a very long period. Spectacular revenue increases of more than 5 per cent. per year are here a thing of the past, and even that rate is doubtful. The experience of the L.M.S. London electrified lines appears to have been brighter, at least if the gain has been due to genuinely new traffic, and not merely to deliberate transference of trains from adjacent lines. This line is not subject to intense municipal tramway competition, whilst the Southern and L.N.E.R. (Eastern) lines have to face the most powerful tramway competition in the world, by virtue of the speed and frequency of their services and their low midday fare rates, which are also offered by through-running omnibuses. Further, great inner suburban areas are already densely populated, and new railway passengers must be sought further out. The roads and road services in the north-west sector of London are much poorer than elsewhere.

Bold and Conservative Schemes.—There is not merely the question of steam or electric traction, but also as to how far the electric service is to extend, both in route and train mileages. There are *bold* schemes and *conservative* schemes of electrification, the former involving great increases of train mileage and the developing of potential traffic on lines now having an infrequent steam service, and the latter implying only a moderate increase of facilities and concerning only very busy lines. This distinction is most important, because proposals in the latter category can be advocated with the greatest confidence, whilst recognising that wider and more extensive electrification may demand a rather optimistic outlook. The Southern scheme falls in the former division, and there is no evidence as yet to encourage other railways to electrify lines with poor services operating against intense road competition, with omnibuses and coaches taking outer suburban midday traffic and tramways gathering the inner suburban passengers. But the electrification of certain North and East London steam services falls in the second or conservative category, since the present frequency is so high that electrical operation would certainly cost little or no more. There is no justification whatever, in the writer's opinion, for steam services to Ilford, Enfield Town, and Chingford, for example, and, though electrification could only slightly mitigate rush-hour congestion, owing to track congestion, it would at least accelerate the stopping trains by some 50 per cent.

In a future article other aspects of this subject will be discussed.

(To be continued).

Centenary of the Leicester and Swannington Railway.

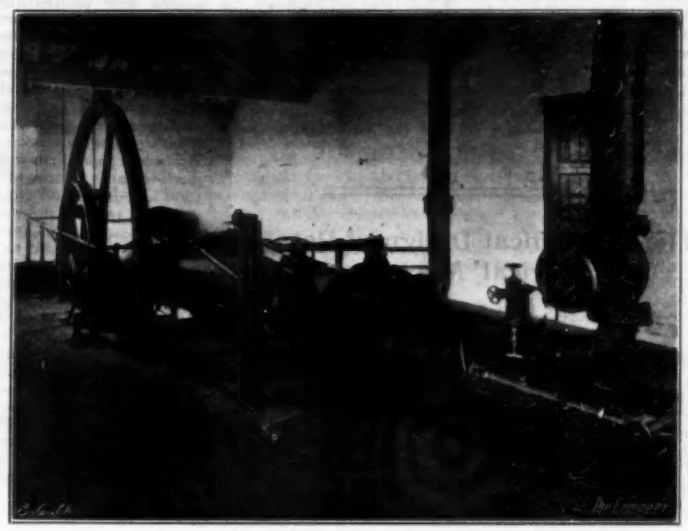
ORIGINS OF THE MIDLAND RAILWAY.

"We owe all our railways to the collieries in the North ; and the difficulties which their industries overcame taught us to make railways and to make locomotives to work them."—*Capt. J. M. Laws, R.N., before the Gauge Commission*, 1845.

THE Leicester and Swannington Railway, the oldest constituent part of the Midland Railway, was built to deal with necessities rather than luxuries. Its origin represented the co-operation of the two factors which laid the foundations of nineteenth century prosperity—native coal supply and cheap transport afforded by the steam railway. Dr. Clapham's recent "Economic History of Modern Britain"—"The Early Railway Age," leaves no doubt on this matter. The story of the railway has been told by Smiles, and with additional detail by Williams in his "History of the Midland Railway." The Leicester Railway originated in the wish of the Leicestershire coalowners to protect their local market from invasion by Northern coal. Plans to effect this result by canals connecting with the Loughborough Canal had been in progress since 1791. There already existed horse railways or tramways from the colliery district of Thringston Bridge and Coleorton at the western edge of Charnwood Forest. This railway system is shown in Cary's County Atlas of 1803, and it was here that Outram and Jessop worked and the invention of the cast iron edge rail took place.

The story of increasing financial difficulties, caused by the excess of cost over the estimate for the canal scheme, is to be found in Phillips' "History of Inland Navigation," 1803, and in the numerous Acts giving powers to raise money for the completion of the undertaking. But, according to Williams, the canal scheme eventually failed by Act of God during the

THE SWANNINGTON WINDING ENGINE, L.M.S. RAILWAY



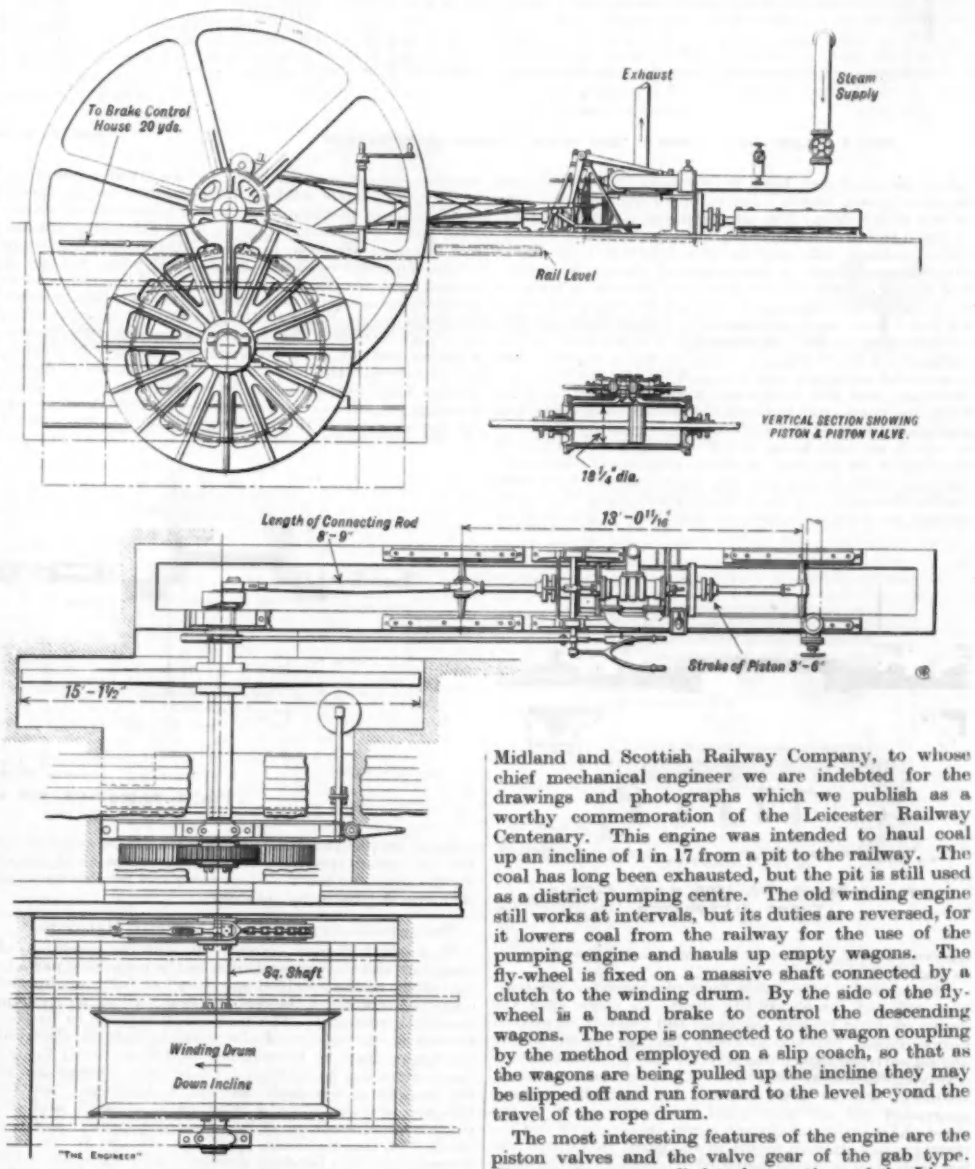
winter of 1798, when the effects of weather destroyed much of the works, which were never restored. When he wrote in 1877 the track of the canal through Charnwood Forest was still discernible and it may be so to-day. By 1829 the steam railway had shown a better way and immediately after the Rainhill trials Robert Stephenson was reported as having gone "about a new line in Leicestershire."

The old motive remained, for although the coal-owners of a hundred years ago on the Tyne and Wear knew all about local self-protection by "quotas," and the difficulties in enforcing them by "regulating the vend" and controlling prices, unlike the Leicestershire owners, they had nothing to fear from the competition of other districts; a Parliamentary Committee in 1830, indeed, looked with disfavour on these methods, and hoped that no other district would imitate them; a hundred years later, in 1930, they were to be made compulsory by Act of Parliament.

Adam Smith remarks that "People of the same trade seldom meet together, even for merriment and diversion, but the conversation ends in a conspiracy against the public, or in some contrivance to raise prices." It may be said for the Leicestershire coal-owners that their object was less to raise prices than to attempt to maintain them against outside competition. Whatever their motives, their "conspiracy" was justified by their new railway, which so reduced the price of coal in Leicester as, according to Smiles, to save that town £40,000 a year in fuel. The effect on the Derbyshire and Nottingham owners was immediate, and caused them to meet, not for merriment and diversion, but to consider steps to preserve their now lost markets in Leicester. Their counter-stroke resulted in the Midland Counties Railway, eventually to become the "Midland." The railways had, in fact, become a two-edged sword, which was in time to deprive every coal district of its geographical protection.

George Stephenson himself had a special interest in the Leicester and Swannington Railway, as owner of the new colliery on the Snibston Estate. It does not seem to have required the special perspicacity which Smiles suggests to suppose that coal would be found there, having in view the existing mines in the district to the west of the Charnwood Forest. The geological conditions are peculiarly interesting. Masses of igneous rock rise in the forest like kopjes above the much later deposits of the Trias, which lie unconformably above the coal measures. The greenstone resulting from volcanic disturbance, which has flowed into these measures and coked the adjacent coal seams, is to be found, exhibiting the same effects, in the great Coaley Hill dyke in the Newcastle coal-field. It was discovered in 1795 and was the subject of a paper by the eminent mining engineer, John Buddle, in 1830. Stephenson no doubt knew of the phenomenon and found greenstone no sufficient reason to abandon his search for coal. But, having found coal, he had to meet difficulties of another kind and to find once more that human nature may be more intractable than rock. A letter written by him to Robert from Alton Grange, near Snibston, has recently been brought to light. He writes on May 16th, 1833:—

> "I find we can make nothing of the men here for their ideas are far too high, they will not get the coal and put them to the shaft under 3/-. I have offered them 2/3 per ton for large coals and 1/- for the cobbles, nothing for the small as we shall leave them under ground. I have got a person here, named Blackburne, who is intended to be an overman, and I think it best to send him back to Newcastle to pick out about 40 of the steadiest hewers he can get, and one putter for every four men. Twenty of them might come back with Blackburne, and 20 might come a month after. We must pay their expenses here. Blackburne will take charge of them and bring them by water to Gainsborough, from thence up the canal to Loughborough. It will be better for Blackburne to make a full explanation of the nature of the coal, and bind the men for 12 months to the prices I have stated. The next seams will vary, of course, more or less, according to the nature of the coal, the prices of which we shall settle by competent judges. I daresay Mr. Wood will let you have a copy of their Bond. You will be aware of the importance of having them here as soon as possible.
>
> . . . P.S.—We have as many men at work as to keep the headings going."



ARRANGEMENT OF WINDING ENGINE

The subsequent influence of these men and of northern mining methods in the district would form an interesting page in colliery history.

It must have been in 1832 or 1833 that Robert Stephenson and Co. supplied a winding engine for the Swannington end of the line, which is to-day one of the treasured historical possessions of the London, Midland and Scottish Railway Company, to whose chief mechanical engineer we are indebted for the drawings and photographs which we publish as a worthy commemoration of the Leicester Railway Centenary. This engine was intended to haul coal up an incline of 1 in 17 from a pit to the railway. The coal has long been exhausted, but the pit is still used as a district pumping centre. The old winding engine still works at intervals, but its duties are reversed, for it lowers coal from the railway for the use of the pumping engine and hauls up empty wagons. The fly-wheel is fixed on a massive shaft connected by a clutch to the winding drum. By the side of the fly-wheel is a band brake to control the descending wagons. The rope is connected to the wagon coupling by the method employed on a slip coach, so that as the wagons are being pulled up the incline they may be slipped off and run forward to the level beyond the travel of the rope drum.

The most interesting features of the engine are the piston valves and the valve gear of the gab type. Piston valves as applied to locomotives of the Liverpool and Manchester Railway in 1832 were illustrated in THE ENGINEER of April 29th this year. They were soon abandoned for locomotive work and were not again adopted for more than half a century. On the old Swannington winding engine they are still in service, though whether the rings, which are of gun-metal, are of the original pattern cannot be stated. The piston valve eases the starting of the engine by hand until the movement of the shaft enables the

excentric rod gab to engage with the driving pin on the valve rocker.

It was stated by Sir Henry Fowler before the Institution of Mechanical Engineers in 1927 that the engine was still employed as a commercial and economic proposition and that it would be a long time before it would need extensive repairs. Its capital value must long ago have been written off, but as a historical monument to those "to whom we owe all our railways," the colliery engineers of the North, we hope that it may long receive the care and respect with which its present proprietors regard it.

The Mechanical Design of Rotating Electrical Machinery.*

By H. W. TAYLOR.

It is interesting to review broadly the state of the art of the mechanical design of electrical machinery in 1881, when the first Congress of Electricians was held, and in 1931, fifty years afterwards, in which year this paper was written. The type of electrical machine mostly in vogue in 1881 was a bipolar direct-current machine and designs similar to those initiated by Gramme were mostly used. The alternating current generator was at that time beginning to receive consideration, and the famous alternators designed and built by Ferranti for the original Deptford power station were in operation within a year or two of this date. The direct-current machine of 1881, of which the Gramme dynamo was typical, had a double-limbed magnet yolk and the armature was ring wound with the conductors on the surface of the armature core. The double-limbed magnet was soon afterwards replaced by the single-limbed magnet, of which the bipolar Hopkinson and Edison machines were typical, and these, in turn, with the demand for higher ratings, were replaced by the multipolar form of magnet which we know to-day. The ring-wound armature was replaced by the barrel-wound armature, and the conductors were embedded in slots. Thus, ten years after 1881 the direct-current machine had practically reached the state of mechanical development in which we now know it. Following a better understanding of the physical or electro-magnetical relations of the vital parts to one another, improvements have been made subsequently in the better proportioning of the constituent parts for the more economical use of materials for a given output. Modern direct-current machines are shown in Figs. 7, 8, and 9.

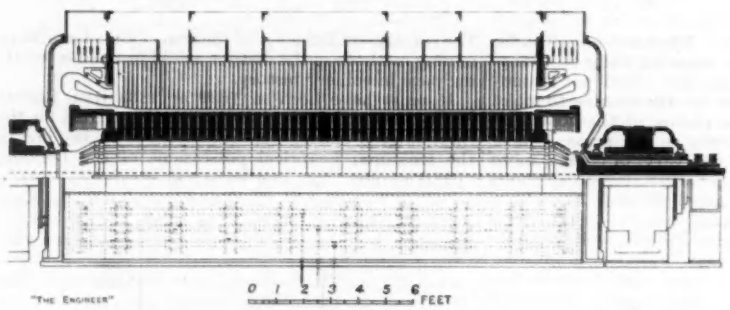


FIG. 1—94,000-kVA. 4-POLE 1500 R.P.M. TURBO-ALTERNATOR

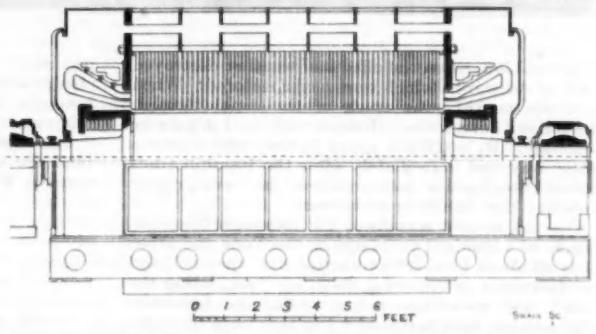


FIG. 2—45,000-kVA 2-POLE 3000 R.P.M. TURBO-ALTERNATOR

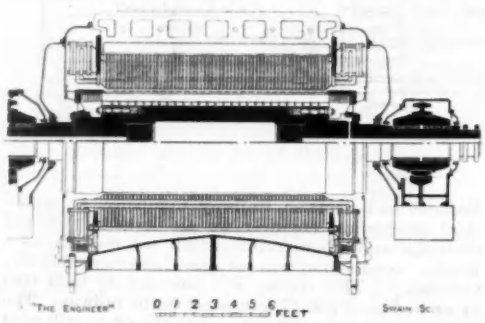


FIG. 3—75,000-kVA 1500 R.P.M. 4-POLE TURBO-ALTERNATOR

The evolution of a stable form of alternator construction was not completed till about ten years after the design of direct-current machines had reached its present normal form. This was probably due, first, to the feeling among early designers that the alternator should have a revolving armature like the direct-current machine; secondly, because large demands for alternating-current generators did not arise until the development of the three-phase system of electric power transmission and the three-phase induction motor in the early 'nineties of the last century gave rise to increased demands for alternating-current generators; and, thirdly, because in breaking away from the revolving armature type of machine, designers were tempted to use for the revolving magnet type which followed, certain simple constructions, which, while they were more suitable than the previous type for generating in one machine larger amounts of alternating-current power, did not do this with an economy in the use of material, as was subsequently proved possible by using a set of revolving salient poles with a magnetising coil for each. Examples of modern salient pole alternating-current machines are given in Figs. 4, 5, and 6.

Almost simultaneously with this stabilising of the salient pole alternating-current generator, as required principally for the reciprocating steam engine, the development of the steam turbine running at much higher speeds than any other form of prime mover, gave rise to another type of alternating-current generator, which, in order to distinguish it from the slow-speed type, became known as the non-salient pole machine. In this, a smooth cylindrical surface is grooved longitudinally to carry a number of separate magnetising coils for each pole. This type of alternator passed through its successive stages of development towards a more or less fixed type between the years 1900 and 1910, and from the end of this period onwards until the present day this type has been adapted to the ever-increasing capacities required by the development of the prime mover and to run at the highest possible speed which is consistent with a bipolar alternator supplying current at a given periodicity. Examples of the non-salient pole type of alternator are given in Figs. 1, 2, and 3.

The development of electrical machinery has afforded ample opportunity for the exercise of the iron and steel founders' art. Probably the heaviest iron castings were required about thirty years ago when the steam turbine, not having been fully developed, the Corliss type of slow-speed reciprocating steam engine was in use for the largest outputs of that time. Proposals were made at about that time to build the larger machine frames as riveted mild steel plate structures, but, as far as the writer knows, little progress was made. However, of recent years developments in another branch of electrical engineering, namely, in electric welding, have resulted in the use of castings being discontinued in favour of electrically welded steel plate structures for most large stationary frames, and instances are given in Figs. 1, 2, 4, 5, and 6. Owing to the supposed weakness of a welded joint, the use of welded steel structures for rotating parts has not been so general, but instances of cases where this has been possible are given in Figs. 5 and 8. Rolled mild steel billet sections, to which feet, lugs for bolting top and bottom halves together and for other purposes, are electrically welded, are now frequently used for the magnet frames of direct-current machines, as shown, for instance, in Fig. 8. Steel forgings are used in various forms (see Figs. 1, 2, and 3) for the rotors of all turbo-alternators, and, in the writer's opinion, the development of larger machines, particularly for the higher speeds, is waiting upon the steel maker for the supply of more homogeneous and reliable material than can at present be obtained.

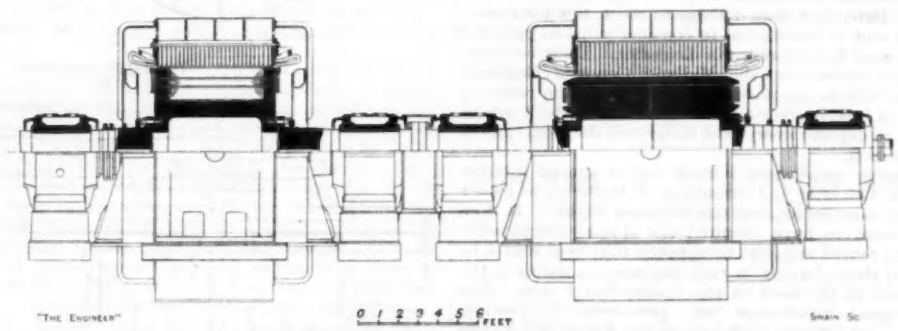


FIG. 4—30,000-kVA 500 R.P.M. FREQUENCY CHANGER

Mechanical Stresses in Electrical Machinery.

Mechanical design consists in suitable selection of materials and the proportioning of the respective parts to run safely at the specified speed and to fulfil any special operating conditions, the resulting design giving a minimum manufacturing cost. The mechanical stresses to be considered in the design of the rotating part of electrical machinery may be summarised as follows:—(1) Centrifugal stress due to rotation; (2) bending stresses due to the sagging of the shaft between its bearings; and (3) torsional stresses when a machine is at work and the conversion of mechanical into electrical energy, and *vice versâ*. In the stationary part the stresses to be considered are:—(1) Bending stresses due to the mass of the frame structure, and also the radial magnetic pull of the poles upon the armature; and (2) torsional stresses, the forces corresponding to which are equal and opposite to those in the rotor when power conversion is taking place. It will be understood that not all the above demand detail consideration in every machine. Indeed, in the smallest machines the mechanical art is applied more in devising processes for quick and repeated manufacture and in adapting the design of the machine to these processes rather than in a detailed consideration of the mechanical stresses in the members of the machine when running.

Centrifugal Stresses.—Dealing now, first, with centrifugal stresses, it is an axiom in the design of electrical machinery that the higher the speed of rotation the smaller will be the machine and therefore the lower will be the cost of materials and manufacture. In general, therefore, it may be stated that except for limitations arising from the form of the prime mover in the case of a generator, or in the character of the industrial application in the case of a motor, the highest possible speed will be adopted so long as such speed does not necessitate the use of higher quality and much more expensive material. The highest speeds of rotation are required with the steam turbine prime mover, and it is in alternators coupled to the steam turbine that hoop or bursting stresses arising from the centrifugal forces generated in the rotating parts have to be given most serious consideration. Their importance will be appreciated when it is remembered that the centrifugal force brought into play by the rotation of a pound weight at a foot radius and at a speed of 3000 r.p.m. is just over 3000 lb.

Probably for the reason that it gives rise to the minimum amount of indeterminate bending stress in the neighbourhood of the tooth tips, the most usual type of mechanical construction is, as already mentioned, the non-salient pole rotor with the windings placed in radial slots. The hoop stresses in the rotor may be estimated by considering a radial section and treating it as for a disc of a diameter corresponding to the bottom of the slots with uniform external loading corresponding to the teeth and coils. In a large 3000 r.p.m. rotor the stress at the inner bore may reach over 30,000 lb. per square inch at normal speed, and although according to theory this value is a local intensification of stress towards the inner bore and by theory can be reduced to approximately half if the material is allowed to remain continuous to the centre, designers consider it preferable to bore a hole along the centre of the forging in order that an examination of the material can be made in that part where it is most likely to be defective, although with the highest speed machines the size of this hole is limited because an enlargement would lead to a further increase in the already high value of the average hoop stress. The most general practice in the construction of 3000 r.p.m. and 3600 r.p.m. rotors is to form the magnetic core and the shaft ends in a single solid forging, as in Fig. 2, and in larger ratings this is of some alloy steel, of which the principal alloy constituent is nickel, with chromium and also possibly molybdenum each in milder proportions. The possibility of the design of more highly rated machines of this type seems to depend upon the steel maker and the forge master producing still larger forgings in a high-tensile alloy steel which will be uniform in strength throughout and particularly will be free from defects such as small holes, cracks, and other mechanical discontinuities. It would seem that in the present state of the art of steel making that the production of a suitable forging becomes increasingly difficult as the diameter of the central portion approaches 40in.

Other types of mechanical construction are possible for lower-speed turbo-alternator rotors, such as those which run at 1800 r.p.m., 1500 r.p.m., 1200 r.p.m., and 1000 r.p.m. Again, the non-salient pole magnetic structure is almost universally adopted at all these speeds. The construction frequently used for the highest ratings consists of a solid forging for the central magnetic body, separate forgings being used for the shaft ends. This is known as the three-piece shaft construction. The provision of a sound mechanical attachment of the ends to the central body does not offer any difficulty. As in Fig. 3, the end portions are spigoted to the central body and a positive attachment is ensured by the use of two or more bolts in the region of each pole which are made of a high-tensile alloy steel so tightened as to be permanently under tension. An alternative attachment consists of inserting dumb-bell keys into grooves provided in the body of the metal across the joint, these being retained against centrifugal force by closing wedges (see Keyser in *Journal*, I.E.E., Vol. 67, page 1112). An interesting feature in

* Paper read before Congres International D'Electricité, Paris.

Fig. 3 is that a plug is forced into each end of the central body with an interference fit so that before the shaft ends are fitted the ends of the body are expanded and stressed to the values which will be attained due to centrifugal forces when running at full speed.

An alternative rotor construction is to use as the magnetic core a number of discs, formed into a mechanical structure either by mounting them with interference fits upon a central shaft (see Fig. 1) or by the use of through bolts of a high-tensile alloy steel. In the latter case the plate at each end of the rotor core is forged as an integral part of the shaft ends (see "Trans.," Am. I.E.E.E., Vol. 47, page 557). With shafts for machines running at 1800 r.p.m. and below it is possible with the sizes and outputs which have been built to date to bore or trepan the material from the inside of the forging corresponding to about one-fifth of its diameter, and as this is the location within which forging defects are most likely to occur, the

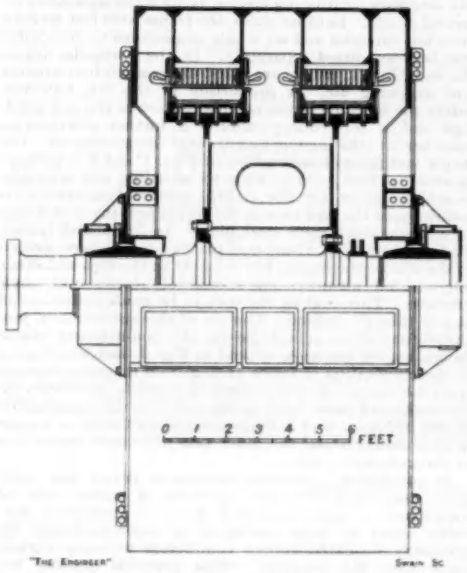


FIG. 5—14,000 H.P. 130 R.P.M. SHIP PROPULSION SYNCHRONOUS MOTOR

production of a safe mechanical structure does not cause the designer so much anxiety as with the 3000 r.p.m. and 3600 r.p.m. machines.

The rings which retain the end windings of turbo-alternator rotors are probably the most highly stressed parts of the machine. There are advantages from the electrical point of view in having these rings in non-magnetic material, and for some years and in the smaller rated machines then built, a high-tensile bronze, sometimes forged after casting, was used for this purpose. A number of failures, however, in some cases after a number of years of service, proved this material to be unreliable and its use was discontinued. During recent years, however, a nickel-manganese steel of austenitic characteristics, which is non-magnetic, has been developed for this purpose. This material can now be obtained with an ultimate strength up to 60 tons per square inch and with an elastic limit of

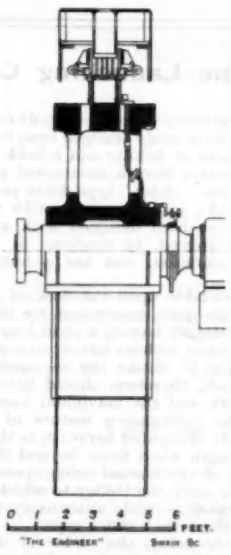


FIG. 6—2750-kW 160 R.P.M. ALTERNATOR

50 tons per square inch. It has also the valuable property of being very ductile and will probably come into general use for retaining rings for all turbo-alternators.

Another detail which requires mechanical consideration is the selection of a suitable dimension of rotor conductor. Unless these are sufficiently wide with reference to the depth of the coil, or unless the spaces between the coils are tightly packed, the assembled coil under the action of centrifugal force when running at speed will act like an unstable strut, the separate piles of conductors under the retaining rings will buckle, and the inner conductor will slip over the outer ones, putting a strain on the insulation where the coils leave the slot and so tending to electrical faults. With the present tendency to ventilate the rotor body by passing air between the various end coils into ventilating slots cut between the winding slots, blocking between coils is reduced to a minimum, so that it is all the more important to ensure that the pile of conductors forming each coil is self-supporting.

With the salient pole type of rotor centrifugal stresses are as a rule not so difficult to deal with and a large variation in construction detail is possible. The speed of revolution for a given rating may be chosen from a wide range according to the purpose for which the machine is intended. Electrically, the salient pole rotor consists

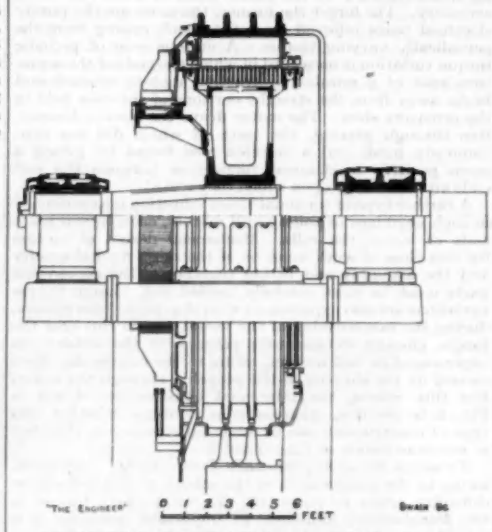


FIG. 7—7000 H.P. 50-120 R.P.M. D.C. MOTOR

essentially of a wheel or rim forming the magnet yokes and from this project at equal intervals the separate cores of the magnetic poles. Each core is surrounded by a coil and the pole has a cap which overhangs the core to retain its coil against centrifugal forces.

In the higher speed machines, as, for instance, in a 1000-kW 50-cycle alternator running at 1000 r.p.m. and suitable for being driven through gears from a steam turbine running at 8000 r.p.m., the magnet yoke would be

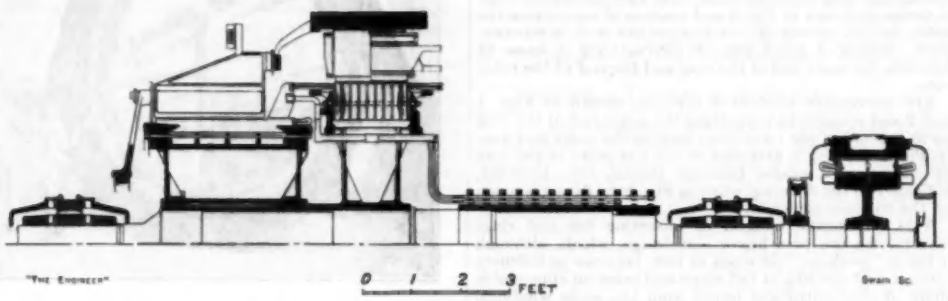


FIG. 8—2500-kW 300 R.P.M. ROTARY CONVERTER

combined in one forging with the shaft, as in turbo-alternator practice (see Fig. 2), while in slower speed machines, as, for instance, for an alternator of the same rating for direct driving from a reciprocating engine at 250 r.p.m., the magnet yokes would consist of a rim of a section at least sufficient to carry the magnetic flux from pole to pole and to sustain in addition to its own centrifugal forces those of the pole and spools. The rim is connected by spokes to a hub which in turn is mounted upon a separate shaft. This construction resembles a fly-wheel and this, indeed, is frequently what the magnet yoke becomes as explained when considering torsional stresses.

The variations in magnet yoke construction for machines of approximately the same rating, but for operating at widely different speeds, are shown in Figs. 4 and 5. The speed of the former, namely, 500 r.p.m., may be considered as the limit for which the salient pole construction is possible for a 25-cycle machine of this rating. In both the machines forming this frequency changing set the magnet yokes are steel castings, constituting also the central portion of a three or four-piece shaft, thus following a similar construction to that shown in Fig. 3 for a large 1500 r.p.m. turbo-alternator. For the other extreme of speed—130 r.p.m.—the magnet yoke (see Fig. 5) is a cast steel ring of large diameter connected by means of radial plate to flanges formed in a forging which is the first length of the ship propeller shaft. In this case the omission of an inner hub is a simplification of the usual construction.

Alternative methods of assembling the poles and spools may be broadly classified as follows:—(1) The poles are solid with the wheel and the coils are retained by a separate pole cap which is attached to the pole by means of screws (see, for instance, the 25-cycle machine in Fig. 4); (2) the pole and cap are in one piece and are made either solid or of punchings assembled together on rivets. The coil is assembled on the pole and the pole is held to the wheel by means of screws (examples are given in Figs. 5 and 6); (3) as an alternative to (2), where mechanical conditions are severe, the assembled pole with spool is held to the yoke by means of dovetails (as in the 50-cycle machine in Fig. 4; see also THE ENGINEER, Vol. 149, page 439). Mechanical instability of exciting coils along the sides of the poles may occur in machines at the higher speeds with the small number of poles, and this is taken care of by V blocks which are held by screws into the metal of the yoke between the poles.

The mechanical design of the rotating parts of D.C. machinery is in general not so difficult as A.C. machinery, principally because such large ratings are not required.

For the low speeds of revolution the largest D.C. machines are required for heavy industrial work, such as for steel rolling mills (see Fig. 7). As regards high speeds of revolution a few machines have been made directly driven by turbines, but mechanical difficulties in construction of the commutator and in the electrical design to ensure sparkless commutation have placed a relatively low limit on the rating of this type of machine. There are, however, a few industrial applications where high-speed D.C. motors are required, such as that shown in Fig. 9. Figs. 7 and 9 afford a good comparison between a slow-speed and a high-speed D.C. machine. In the former the laminated armature core is assembled upon a spider with hub which is pressed on to a separate shaft. The armature windings, supported upon light brackets springing from the flanges, are lightly held by one or two layers of binding wire. The commutator shell is bracketed from the spokes of the spider and the commutator bars are held by a V ring at each end. In the high-speed machine the armature laminations are mounted directly upon the shaft. Many layers of binding wire are required to retain the end windings and the commutator is separated from the shaft only by insulation and a thin tightening cone ring at one end, the segments being retained against centrifugal force by heavy shrink rings. The radial faces of the commutator bars in the grooves between the shrink rings are in this machine used for current collection.

Bending Stress.—As the fibres of the shaft experience a complete cycle of compression and extension with every revolution of the rotor and, as already pointed out, electrical machinery is designed to run at as high a speed of revolution as possible, the material will suffer from stress fatigue if the stresses arising from bending are not kept to a low value. As a rule, the maximum bending stress does not much exceed 2 tons per square inch. It will have been noticed that in high-speed machines, in order to deal with centrifugal forces, the magnet yoke and the shaft are often combined into one forging and even with this arrangement the centrifugal stresses in association with the mechanical properties of the steel used for the rotor forging set a limit on the diameter of a particular type of machine running at a given speed. Larger outputs can only be obtained by increasing the length of the magnetic core used in a previous design. Such an increase in length gives higher bending stresses, which in the limit place a restriction on the output for which a machine of a given type and at a given speed can be designed. This limitation in regard to a 3000 and 3600 r.p.m. alternator seems to be in sight, but at the lower speed much larger outputs are possible than in either of the constructions shown in Figs. 1 and 3. As the limit is approached a further margin can be obtained by placing the slip rings outside the bearings, as in Figs. 1 and 3, and by ventilating with external fans, as in Figs. 1 and 2.

Associated with the bending of the shaft is the critical speed of the rotor. This is the speed at which, if the rotating structure is out of mechanical balance and if the molecular friction forces during vibration are negligible, the rotor will vibrate with increasing severity. It is in general the aim of designers of electrical machines to make the rotating structure stiff, by which is meant that the

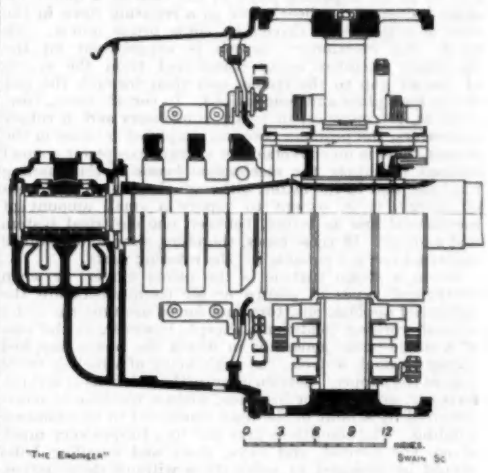


FIG. 9—210 H.P. 3600 R.P.M. D.C. MOTOR

critical speed will be above the running speed. Practically all slow-speed machines can be designed in this way, but with the large output alternators, running at the highest speeds it has been found impossible with a diameter which keeps centrifugal stresses within reasonable limits and a length then chosen which will give the required output, to design a shaft which is stiff. In consequence for many years many 3000 r.p.m. turbo-alternator shafts have been flexible, by which is meant that the critical speed is below the running speed, so that the rotor has to pass through

its critical speed every time it is run up and every time it is brought to rest. Experience seems to indicate that for such machines it is best to have the critical speed at least half the maximum emergency speed at which the machine is expected to run. As a rule, medium-speed turbo-alternators have stiff shafts, although some of the largest machines have been built with flexible shafts, having critical speeds of about two-thirds of the normal running speed. The machine in Fig. 1 has a flexible shaft, while that shown in Fig. 3 has a stiff shaft.

Reverting to the bending of shafts, and particularly in the slower speed machines, it is advisable over a region where a spider or some other member is mounted upon the shaft that there should be as little bending as possible, because inasmuch as it is difficult to ensure so tight a fit that the spider structure and the shaft conform to one another in bending, movements will take place between the two members and after a number of revolutions corresponding to even a reasonable period of service, the fits will wear and the spider will in time become loose upon the shaft. Examples, however, where there is very little bending in the shaft so that the spider can be fitted without fear of subsequent wear in the fit, are shown in Figs. 6 and 7. The separate plates in the rotor in Fig. 1 are eased at the ends of the fits, and in order that the plates by occasional contact only in certain radial positions do not cause the neutral axis of bending to vary from the mass axis about which the shaft is balanced, successive plates are not mounted in contact with one another, the prescribed distance between them being preserved by a screw head fixed as near the inner radius of each plate as possible.

The question of the bending of the shaft in relation to members that are mounted upon it requires careful consideration in the case of commutators, as otherwise alternating stresses in correspondence with the revolution of the armature cause the commutator lugs connecting the commutator bars to the armature windings to fracture after a period of running. In the high-speed motor in Fig. 9 the armature laminations being mounted directly upon a shaft allow the latter to be as stiff as possible, in addition to which the form of commutator connection gives it a degree of flexibility which allows it to adapt itself to the minute relative movements between the commutator and the armature.

Still another example of difficulties arising from the bending of the shaft is the mounting of the end winding retaining rings on turbo-alternators. These rings are mounted at the end of the core where the shaft becomes considerably reduced in diameter, so that the curvature of the shaft is probably greatest along the region over which the rings are mounted, and for this reason designs are in use which do not attempt to mechanically support both ends of the ring from the shaft. An example of one type of design is shown in Fig. 3 and consists of supporting the outer end by means of interference fits with a separate plate, leaving a small gap or alternatively a loose fit between the inner end of the ring and the end of the rotor core.

The alternative method is typically shown in Figs. 1 and 2 and consists in supporting the inner end of the ring on to the end of the rotor core, leaving the outer end free. In Fig. 1 the ring is attached to the last plate of the core by means of a coarse buttress thread, not, however, indicated on the drawing, while in Fig. 2 the fitting is made on the bayonet principle.

This alternative method of mounting the end rings permits the use of a heavy end flange, which, although it has a "push-on" fit when at rest, becomes in intimate contact with the ring at full speed and takes an appreciable share of the centrifugal forces from the rotor windings. The fact that the outer diameter of these flanges as shown in Figs. 1 and 2, is greater than the stator face diameter, and so necessitates the flange at the turbine end being removed during assembly or dismantling, has not been found to be a serious objection to their use.

Torsional Stresses.—The current in the armature conductors causes the magnetic flux as it passes across the air gap into the tops of the armature teeth to be distorted, and this is the electro-magnetical aspect of the mechanical torque which becomes transferred from the teeth to the body of the armature core in the case of a D.C. machine, or from the pole face to the pole core in an A.C. machine, and so on in each case to the spider and to the shaft, and so as an impelling force in the case of a motor for some industrial application or as a resisting force in the case of a generator driven by some prime mover. An equal and reactionary torque is experienced on the stationary member being transferred from the region of the air gap to the frame, and then through the feet to the base plate and foundations. In certain cases, however, as, for instance, in rotary condensers and in rotary converters, the problem becomes simplified because in the former there is no conversion of energy, except for a small amount to supply the mechanical losses of the running machine, and in the latter, although there is a conversion of energy, it is, except to supply a small amount of mechanical loss as before, between one electrical system and another. In these cases, therefore, simple mechanical constructions are possible for the rotating parts.

When a steam turbine is the prime mover, or when centrifugal types of pumps or air compressors are the industrial applications, torsional forces are uniform under normal working conditions, except, however, in the case of a single-phase generator in which the power supplied passes through a cycle, the periodicity of which is twice that of the supply. Certain abnormal conditions of service, however, arise, as, for instance, when a machine is short-circuited by a fault in the lines connected to its armature winding. The conditions give rise to a torque very much above the normal, and keys, shaft and coupling bolts should be designed to resist these without deformation. These excessive torques impose a sudden change in speed on all the rotating parts, and those which, under normal operation, do not assist in the transfer of the working torque will experience a tendency to move with reference to the rest of the rotating structure. For this reason, commutators should be keyed to the shaft, or should be dowelled to the spider as the design requires, and the ends of the armature coils should be tightly held by the binding wire on to the supporting brackets. For the same reason some designers fit driving keys between the retaining rings of turbo-alternators and their supports, and the buttress thread by which the rings in Fig. 1 are attached to the core are right-handed at one end of the machine and left-handed at the other, so that, according to the direction of rotation, the rings tend to screw on tighter when the alternator is short circuited.

Other types of prime mover and other industrial applications give rise to periodic variations of torque during each revolution. In order to limit the cyclic irregularity of rotation a fly-wheel is usually included in the equipment, and in the extreme case of the large gas engine generator, for instance, as shown in Fig. 6, the essential electrical parts are dwarfed by the massiveness of this mechanical accessory. The larger the former, the more are the purely electrical parts relieved from the shock arising from the periodically varying torque. A curious case of periodic torque variation is on record in which the ends of the armature coils of a number of traction motors cracked and broke away from the straight portions of the coils held in the armature slots. The motor drove the electric locomotive through gearing, the teeth of which did not continuously mesh and a solution was found by giving a more positive mechanical connection between the coil ends and the flange upon which they rested.

A further type of torsional stress vibration is experienced in such machines as rolling mill motors, each time a billet ends or leaves the rolls. Mechanical design of motors for this class of work must be of the most rigid character and the assembly and fitting together of the component parts must be most carefully carried out. Large torque variations are also experienced with ship propulsion motors, during the manœuvring of the vessel, but in this case the torque changes do not take place with the suddenness experienced in mill motors, owing to the cushioning effect caused by the slipping of the propeller through the water. For this reason, the fabricated construction shown in Fig. 5 is possible, whereas it is doubtful whether this type of construction can be made satisfactory on the class of machine shown in Figs. 6 and 7.

Torsional Stress in Stationary Part.—In D.C. machines, owing to the massiveness of the salient pole structure, no difficulty arises in conveying the reactionary torque to the foundations, although, in important machines it is considered advisable to fix non-magnetic struts between the tips of the main poles and the commutating poles,

FIG. 10—FRAME OF 2750-kW 160 R.P.M. ALTERNATOR

so as to make the whole of the circular face of the magnet system mechanically continuous. In A.C. machines the reactionary torque has in the past been the cause after a period of service of broken stator teeth and looseness at the back of the core between laminations and the dovetail keys upon which they are mounted. Longitudinal clamping of the laminations seems to be a preventive of troubles of this kind, but, following the principle adopted in D.C. construction as indicated above, it is advisable that the wedges used in the stator slots to retain coils should also effect a wedging action between adjacent teeth, and where a deep open space is allowed at the front of the slot, either for increasing the reactance of the machine, or for ventilating purposes, a further wedge may be used at the front of the slot to ensure mechanical continuity between each tooth and the next on either side.

Bending Stress.—As the stationary structures are supported continuously along their feet, longitudinal bending stresses are negligible, but partly owing to the mass of the structure, and partly from the fact that any irregularity in the length of the air gap with different poles will give rise to an unbalanced magnetic pull upon the frame, circumferential bending of the frame needs serious consideration. Again, the problem is more readily dealt with in D.C. machines for the necessary area of the yoke for carrying magnetic flux usually provides a section stiff enough to act as a mechanical support for its own mass and that of the various poles and spools. If necessary, as in Fig. 7, a section of the frame may be ribbed or even given an I or other similar section, which is mechanically stronger to resist bending than the plain rectangular frame, found sufficient in small machines and as illustrated in Fig. 8. Additional supports at the bottom of the frame, as in Fig. 7, by adjusting the sagging at this position, also tend to preserve a true circular shape in all other positions.

In alternating-current machines the frame is not an essential member in the electrical operation of the machine, serving only as a mechanical support for the stator core, but inasmuch as the structure of a large bridge has to be designed more to support its own weight than the mere roadway and traffic which it has to carry, so in the stationary part of large-diameter, slow-speed alternators—as, for instance, in Fig. 6—the laminations may be dwarfed by the section of the frame necessary to ensure a stiff mechanical structure. The illustration of this frame, shown in Fig. 10, illustrates better than the line drawing how steps may be taken in this type of frame, when of the fabricated type, to ensure stiffness with a minimum weight of material.

In the turbine driven type of machine, difficulties with stiffness of frame are minimised and the radial depth of the laminations, although made up in segments, contribute, when assembled tightly together, to the stiffness of the structure. A magnetic pull effect is sometimes noticed in these machines, particularly when bipolar, in that the complete structure vibrates like a bell at twice the electrical frequency. The vibration may be detected by a delicate vibrometer attached to the frame, but it may be more apparent in some other nearby structure which has a corresponding natural mechanical frequency. The phenomenon may be considered a tidal effect, resulting from the magnetic pull of each rotor pole upon the stator structure.

A large number of detail variations occur with different manufacturers in the construction of fabricated frames for this type of machine, such variations often being associated with different methods of ventilation. For instance, in order to facilitate transport of a completely wound frame and core, the frame has been made of minimum diameter, another frame incorporating feet and the necessary ventilating spaces, being fixed separately on arrival at site. In other cases, the frame with feet forms a unit, but canopies and air trunk connections to air coolers and fans are fitted separately. In the particular frame shown in Fig. 1, trunks are fitted underneath for outgoing and incoming air. A proportion of the air, however, enters the machine in the neighbourhood of the end windings and a top canopy affords a further distributing chamber into the ingoing longitudinal compartments. The stator and flange construction in Figs. 1 and 2 is perhaps unusual in that with a view to affording the strongest possible support for the tightly packed laminations, it incorporates the end face of the frame and the core flange as a single thick mild steel plate. In fabricated frames made in this way, these end plates are nowhere welded to the rest of the frame, but are held to the feet and other longitudinal members by means of screws and angle brackets. This enables the core to be readily dismantled at any time if required. The use of this construction precludes for reasons of cost the use of a non-magnetic stator flange, as, for instance, is used in Fig. 3, and which aims at the elimination of losses arising from magnetic leakage from the stator coils when carrying current. However, the elimination of these losses is attempted in the construction shown in Figs. 1 and 2, by forming a stout sheet of copper or aluminium round the outer side and inner radial face of the mile steel plate.

In conclusion, a further mechanical detail, not, however, associated with any question of stress, may be mentioned in conncetion with Fig. 1. Increasing difficulty arises in large machines in accommodating the necessary insulated copper conductors to carry current away from the machine. Most previous practice has been to bring the leads down through the bottom half of the shields into the incoming air space, but with the development of external ventilating fans and the trunking to carry air backwards and forwards between the machine, the fans and the air coolers, difficulties arise in making a suitable lay-out of leads and yet preserving suitable ventilating passages. Further difficulties arise inside the stator end covers in neatly arranging cross connections between groups of coils and to the terminals. These various difficulties have been met in the machine in Fig. 1 by arranging the stator windings in two parallel circuits, each of which has its cross and terminal connections at one or the other end of the machine. The machine leads are then brought out through the end covers just above the floor level, the high-voltage phase leads from both ends on one side of the machine, and neutral phase leads from both ends on the other side. Bus-bars are mounted in an enclosure built along the sides of the machine, and the combined connections from both windings are finally carried away through openings in the sides of the foundations.

Aeroplane Launching Catapult.

AMONG the various designs of catapult for the launching of aircraft that have lately emerged from the experimental stage to the realm of definite and reliable service, one of the most interesting from a mechanical point of view is that known as the "slider" type developed by Ransomes and Rapier, Ltd., in conjunction with the Admiralty. This machine has been designed with a view to compactness when stowed, to economy in weight and to simplicity of operation, and has a number of unique features.

The room available upon the deck of a battleship or liner is as a rule quite insufficient for the stowage and training of a catapult having a rigid length requisite for the firing of aircraft without having recourse to unreasonable acceleration to obtain the required velocity. All forms of catapult, therefore, should have the minimum of stowed length and the maximum length possible for operation. The outstanding feature of the particular form of catapult illustrated herewith is the fact that the extension in length when firing beyond the length when stowed is part of the normal firing operation. The rail members which carry the trolley to which the aircraft is attached are made to slide extensively upon the main girder—hence the term "slider type."

Preparatory to firing, the slider is drawn back to a position in which it overhangs the main girder, and the trolley which carries the aeroplane rests upon the slider at its extreme overhung end. On firing the slider is thrust forward until it overhangs the front end of the girder by a considerable amount, the trolley meanwhile travelling upon the slider its full length, and thus giving to the aeroplane a trip equal in length to the motion of the trolley relatively to the slider plus that of the slider.

From the accompanying line engraving the arrangement of wire ropes by which the motion is carried out will be understood. The relative movement of the slider and trolley in the light type of catapult is obtained in two stages, the slider being made to move at twice the velocity of the piston and the trolley at twice that of the slider. In the heavier type of catapult the motion is developed in one stage only, but with a greater rope multiplication, the slider being attached directly to the piston and the trolley being arranged to travel at three times the piston velocity. The light type of catapult is capable of launch-

ing aeroplanes of 5000 lb. weight at 57 miles per hour, and the heavy type machines of 8000 lb. at 57 miles per hour, or lighter aeroplanes at a higher speed.

The advantages claimed for the design, which is patented, are threefold :—(1) The relative velocity of the trolley and track is much less than it would be were the trolley to travel upon the fixed girder. (2) The stowed length of the catapult is less for a given travel of the trolley by the amount by which the slider is made to move. (3) The total weight of the catapult is less than that of other types, as it provides automatically the requisite lengthening of the track, thereby obviating the necessity for and complications of telescopic main girders.

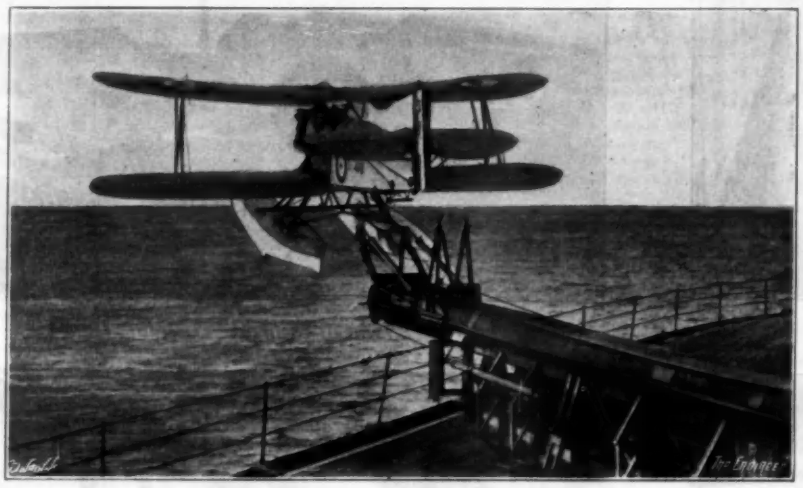
Both light and heavy type catapults on this principle have been built by Ransomes and Rapier, Ltd., and have, we are informed, proved highly successful in practice. Such improvements as have been found desirable in successive machines have, we understand, only been of a comparatively minor character.

Reference to the engravings on page 136 will show that the main girder or structure is mounted upon a centre about which it can be revolved electrically or by hand for training purposes. Clamps are provided in order that the structure may be rigidly fixed to a circular race rail securely attached to the deck of the vessel. The main girders are of riveted and welded high-tensile steel sections and plates, and upon them the slider is carried. As correctness of alignment is of great importance, all surfaces which have an effect upon the working of the apparatus are planed to high accuracy, so as to ensure that the slider and girder and the trolley and slider shall bear fairly and truly throughout the operation. The slider may be arranged to slide on the girder in machined grooves or rails or it may be carried upon adjustable rollers fitted with ball bearings. Both arrangements have been successfully tried out and adopted. The trolley is of a simple form, and is designed to carry the standard pattern of superstructure, which is adjustable to accommodate a large range of aircraft.

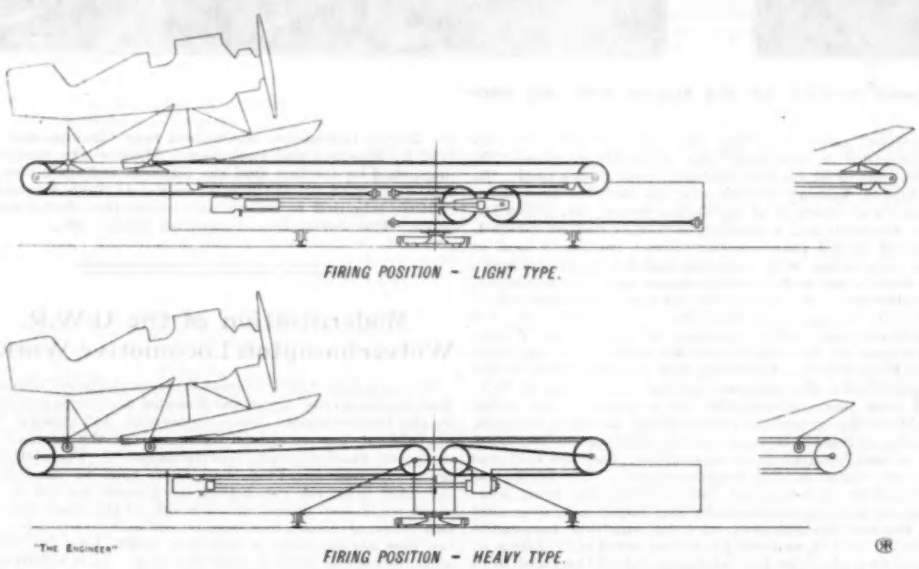
While the rope arrangements do not call for a detailed description, it may be remarked that tightening gear is provided. The rope anchorages are fitted with adjustment and rubber shock absorbers, which, added to the natural elasticity of the ropes, effectively prevent heavy shocks being thrown upon the moving parts. The pulleys are of pressed high-tensile steel plate, the rims being forged and machined to a high degree of accuracy. They are mounted upon ball and roller bearings.

The propellant is applied in a chamber at the back end of the operating cylinder and may be cordite or compressed air. The breech mechanism and valve gear are arranged to suit the form of propellant used. An expansion chamber permits quite moderate pressures to be applied to the piston, and thereby ensures a degree of ease of operation and controllability which is very desirable. The retarding of the moving parts on the completion of the working stroke is effected by a dashpot action, liquid being forced through holes of varying diameter and shape, or, alternatively, forced through tapering keyways, so as to obtain the required degree of regular deceleration without shock. The ratio of the retard stroke to the working stroke is about 1 : 5, with a proportional increase in the deceleration over the acceleration. The forces represented by these figures have been found to be quite controllable. After the completion of the retard stroke, the return stroke is effected by an electric motor or by hand. The fluid automatically returns to its operating position from its storage tank ready for the next stroke.

One essential feature remains to be mentioned, namely, the release hook. Preparatory to firing, the pilot starts up his engine and runs it all out ready for the take-off. It is therefore most essential that the aeroplane should not in any way tend to operate the catapult. A vertical bar or bolt is therefore fixed to depend from the slider and to engage with spring-controlled rollers carried on lever gear attached to the main girder. The arrangement is such that no tractive force from the plane is sufficient to break open the toggle by which the rollers hold the dependent pin. The spring pressures controlling these rollers are adjustable and calibrated so that the operators can see at a glance exactly what pressure will be required to open the "hook." This apparatus has been tested in a number of ways and has been found, we learn, to be quite trustworthy. It will be understood that with the aircraft engine running, the moment the charge is fired there will be an overwhelming force, which will open the hook without fail. In a somewhat similar manner the superstructure which connects the aeroplane with the trolley is made of such a form as to hold the machine securely preparatory to the launch, but to release it equally surely during its passage along the catapult.



LAUNCHING A SEAPLANE BY CATAPULT



FIRING POSITION - LIGHT TYPE.

FIRING POSITION - HEAVY TYPE.

LIGHT AND HEAVY PATTERNS OF SLIDER CATAPULT

American Engineering News.

Vanadium in High-speed Cutting Tools.

WHILE 1 per cent. vanadium with 4 per cent. chromium is a general proportion in high-speed tool steel, some American makers have increased the vanadium content to 2 and even 5 per cent., in addition to the usual tungsten and chromium. Carbon has been increased in proportion until 0·80 per cent. is common, while with 5 per cent. vanadium the carbon has been made 1 or even 1·2 per cent. In lathe tests under controlled conditions, the length of chip cut before failure was 2298ft. with standard high-speed steel, but from 3315ft. to 6890ft. with steel having 3·8 to 6·5 per cent. vanadium in combination with 1·2 to 1·7 per cent. carbon. It is considered that 0·2 of carbon may be added to each 1 per cent. of vanadium, without causing difficulties in forging until the carbon reaches 1·6. But the upper limit of vanadium and carbon contents has yet to be determined. The vanadium-carbon steels show a marked increase in cutting efficiency, with no appreciable reduction in toughness. Similar improvements may be obtained by increasing the vanadium and carbon in cobalt high-speed steel. With 4·31 to 6·22 per cent. vanadium and 5·7 to 8·76 per cent. of cobalt, and 1·18 to 1·66 per cent. carbon, the lathe performance was considered remarkably good. Although the action of vanadium in the steel has not been determined, one reason considered obvious is its effect in limiting the size of grain in the steel, while it is also known to be a powerful former of carbide of fine texture, which probably improves the cutting efficiency without having any effect on other physical properties.

An American 250-Mile Aqueduct.

To bring water from the Colorado River in Arizona, to a group of cities on the Pacific Coast of California, will require a viaduct nearly 250 miles long, and a total static pumping lift of nearly 1600ft., in order to cross intervening mountain ranges. From a receiving reservoir on the river, the water will be pumped up 294ft. to one reservoir, and then 298ft. to another reservoir, all in the first 5 miles. At 70 miles comes a 137ft. lift ; followed between miles 110 and 120 by two lifts of 125ft. and 282ft. Near mile 130 is the final lift of 460ft. The engineering construction work will include 85 miles of tunnels, including one 13 miles in length ; 55 miles of conduit of horseshoe section in cut and cover ; 75 miles of open canal ; 25 miles of concrete pipe lines, and 2 miles of flow through reservoirs. The tunnels will be 15½ft. wide and high, with concrete lining. The conduit section will be 18ft. wide at floor, 20ft. at maximum width, and 16½ft. high. In both cases the water depth will be about 13ft. For the canals, there will be a bottom width of 22ft. and side slopes of 1 vertical in 1½, with a water depth of 12ft. and a 5ft. freeboard. The aqueduct will terminate at a reservoir, from which three lines of conduits will diverge to serve different groups of cities. A dozen cities having a combined population of 1,666,000 have organised a water district for this purpose, and several other coast cities will probably be included. The diversion from the river will be from 1500 to 1600 cubic feet per second. Electric power for pumping will come mainly from the hydro-electric plant at the great Hoover Dam, now under construction some 160 miles further up the river. The total cost will be about 220 million dollars, or about £60,000,000. Work is expected to begin before the end of 1932.

Treatment of Domestic Water Supply.

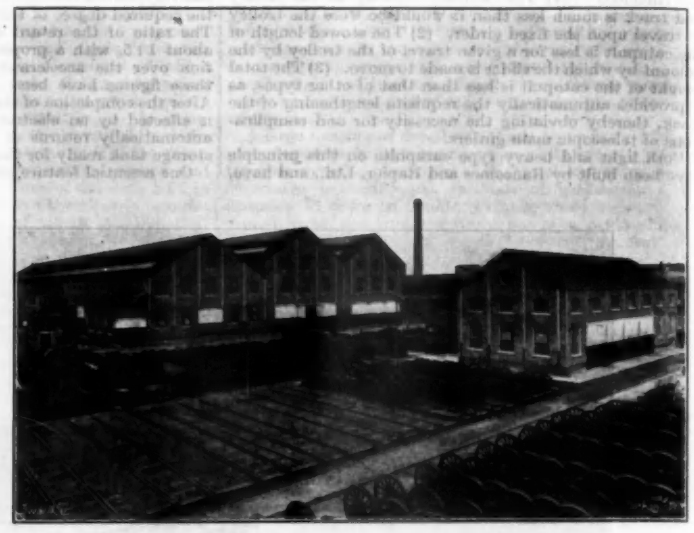
At the annual meeting of the American Water-works Association considerable attention was given to recent developments in filtration and other treatment. For the past three years the filters at Cleveland have had the application of wash water varied with the temperature of the water, high rates of wash water being used during warm weather. As compared with the previous three years, the benefits of this practice have exceeded expectations ; the filter runs between washings have been lengthened 66 per cent., the consumption of wash water has been reduced 33 per cent., and the bacterial efficiencies have been improved. At several cities, experiments are being made to determine the physical laws which govern the loss of head in the filter sand under different conditions of size of grains, packing of sand in the bed, and temperature of water. Aeration gives valuable results in different ways, but especially in the removal of iron and the elimination of odours and tastes due to the presence of micro-organisms, but it is not effective with odours caused by trade wastes. For such odours, treatment by the relatively new activated-carbon method has proved successful, even in a bad case in which water was polluted by wastes from a chemical works. Manganese in water has a bad effect on the filters, as it is likely to collect on the sand grains and cause the bed to become clogged. Such water is sometimes treated with lime and alum before filtration, in order to precipitate both manganese and iron. A still more effective treatment is to use lime and copperas, the latter being more effective than alum as a coagulant. There is thought to be need for more experimental work in sedimentation, particularly to determine the relative importance of volume and surface area of the basin.

Railway Wheels in America.

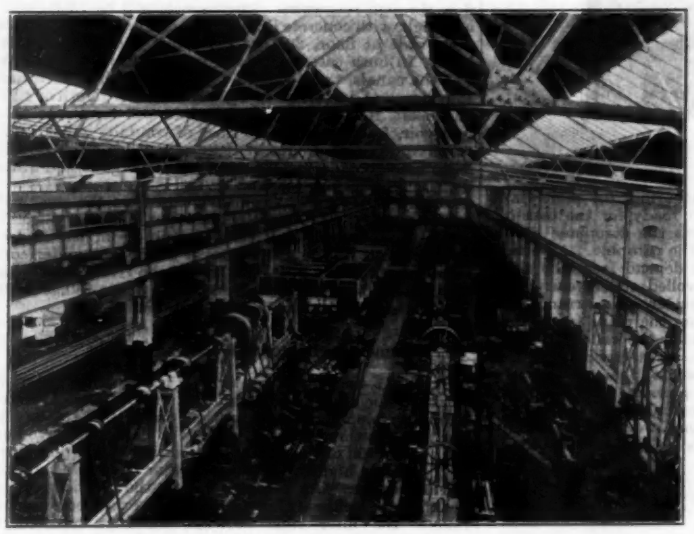
Under present standards for wheels on American railways, the tread has an inclination or coning of 1 in 20, for that part which takes a bearing on the rail, and then a steeper inclination to the outside of the rim. The New York Central Railroad prefers the flatter slope of 1 in 38, but otherwise the standard contour of tread and flange is practically universal. For some time, however, experiments have been in progress with wheels in which the entire width of tread has the 1 in 20 slope, and this arrangement has now been recommended definitely by the mechanical division of the American Railway Engineering Association. It will increase the bearing area, and by eliminating the break at the intersection of the two slopes it is expected to reduce the tendency to the development of thermal checks, a large percentage of which occur on this dividing line. In fact, one railway reports freedom from such checking in tires having the single inclination. Service tests which have been under observation for four or five years indicate that there is little difference in service of wheels of the two sections. In the new section the flange depth is reduced from 1⅛in. to 1in., with a fillet or throat radius of ⅜in., and the total width of tire remains at 5½in. The design now submitted for a ballot vote is for steel and steel-tired wheels on locomotives and cars, but may be recommended later for cast iron wheels. For these latter wheels there is a recommendation to increase the depth of chill on the tread from ¾in. to 1¼in. As to the wear of cast steel wheels for cars, it is considered that these can safely be turned and re-used, provided the thickness is

G.W.R. WOLVERHAMPTON LOCOMOTIVE WORKS

ERECTING SHOP



WHEEL STORAGE YARD



MACHINE SECTION OF THE ENGINE ERECTING SHOP

at least equal to that required for wrought steel wheels, namely, 1¼in. for goods wagons and 1⅜in. for passenger cars.

Nickel Alloy Steel Castings.

Demands for steel parts that will meet varied and high requirements has led to special developments in the American steel casting industry, with a wide range in chemical composition. Failures have been caused in many cases by the use of steel not well adapted to the purpose for which it was applied. For instance, locomotive frames need strength to resist impact, shock and fatigue stresses. Several combinations of nickel with other alloys are used for castings requiring high strength and toughness; thus nickel-chromium steels are used for gears, sprockets, and dies, while with a rather high manganese content the chromium is correspondingly reduced to prevent brittleness. For such heavy castings as rolls, large gears, and rolling mill pinions, castings of nickel-molybdenum, nickel-vanadium, and nickel-chromium-molybdenum steels are used. For a combination of resistance to shock and abrasion, nickel-chromium steel is widely used, with a great variety of proportions to meet varying requirements. Design of the casting is important for good service and economy, and alloy castings require good foundry practice, as well as chemical and metallurgical control. Heat treatment also is even more important in alloy steel castings than for rolled or forged alloy steels. This is particularly the case for castings that will be subject to shock and repeated stresses. The treatment includes annealing, normalising, quenching, and tempering. Extended research, study, and experiment for the purpose of developing alloy metals of high quality have been carried out by the Steel Founders' Society. These metals are alloyed largely with nickel in combination with chromium, manganese, vanadium, and molybdenum.

SIXTY YEARS AGO.

In 1872 the Iron and Steel Institute held its annual provincial meeting at Glasgow. It was the first time the Institute had visited Scotland, and naturally it found much to interest it in the country's long and honourable association with the iron industry. Addressing the meeting from the presidential chair, Bessemer, as reported in our issue of August 9th, 1872, attributed Scotland's prominence as an iron manufacturing centre to two chief factors, Mushet's discovery of blackband ironstone in Scotland and Neilson's invention of the hot blast. In a subsequent paper on "The Rise and Progress of Iron Manufacture in Scotland," Mr. John Mayer gave 1760 as the year in which iron smelting began in Scotland. On the first of January of that year, he said, the first blast-furnace was blown in at the Carron Ironworks, which Dr. John Roebuck and a number of friends had established. Scotland is still proud of her Carron Ironworks, and of their association with Smeaton and his blowing engine, and with Watt and his early steam engine experiments. It is, however, only just to record and to remember that, with the exception of Caddell of Cockenzie, all the originators and early managers of the Carron Works, and almost all the skilled artisans which they employed were Englishmen. Following the establishment of the Carron Works, the next attempt at ironmaking in Scotland took place, about 1763, at a place which to-day would hardly appeal to industrialists as being suitable, namely, at Bonaw, in Argyleshire. The ore was hematite, but it was brought from Lancashire, and the fuel was charcoal made in the neighbourhood. The blast was obtained by water power derived from the river Awe. From the wording employed by Mr. Mayer, we gather that the Bonaw establishment was still smelting Lancashire hematite in 1872, and was producing crucible steel from it. Argyleshire also saw the establishment of the third ironworks in Scotland, at Coatfield, but thereafter the centre of the industry shifted to Lanarkshire and the neighbourhood of Glasgow. At Wilsontown, in the upper ward of Lanarkshire, the brothers Wilson in 1780 erected blast-furnaces to work in conjunction with their ironfoundry. Later a forge was added, and in 1804 a rolling mill was erected. In 1821 the works were acquired by Messrs. Dixon, of Govan, and were continued by them until 1842. It was at the Wilsontown works, according to Mr. Mayer, that raw coal was first used successfully in blast-furnaces, although some of the audience were inclined to attribute that development to Mr. Derby, of Colebrooke Dale. The Muirkirk Works in Ayrshire, and the Ornoa Works in Lanarkshire were established in 1787. At Muirkirk for many years hammered iron was exclusively produced, and so excellent was it that as much as £25 a ton was obtained for it. It was at Muirkirk, too, that at a different date the cheapest pig iron ever produced in Scotland was made. This iron was sold in Glasgow after being carted nearly 30 miles at 35s. a ton. The profit realised was stated to be 6d. per ton. The Clyde Ironworks were started in 1788. It was at them that David Mushet began his career and that Neilson carried out his experiments on the hot blast. The Calder Works were established in 1801 by Mushet and William Dixon, and at them blackband ironstone was first smelted. Of the remaining ironworks mentioned by Mr. Mayer, we can speak only of one, the Devon Ironworks, established near Clackmannan in 1792 by Roebuck and Longridge. These works were distinguished by the fact that the furnaces and the air vault were excavated out of the solid rock. At them Alexander Christie laboured to collect and utilise the blast-furnace gases. The works were dismantled about 1857.

Modernisation of the G.W.R. Wolverhampton Locomotive Works.

It is announced by the Great Western Railway Company that, taking advantage of the financial assistance provided by the Developments (Loan, Guarantee, and Grants) Act of 1929, it has completely reorganised the locomotive works at Stafford-road, Wolverhampton. These works, originally built in 1856, had from time to time been extended, with the result that the general lay-out of the plant which had spread on each side of the main road at two different levels, had become difficult to operate. In the new arrangement a building, 450ft. long by 196ft. wide, forms the main locomotive shop. It is subdivided into three bays, two of which compose the erecting shop, the third being the machine and wheel shop. Each bay of the erecting shop is equipped with two 50-ton overhead electric cranes, whilst in the machine bay there are two 6-ton cranes of the same type. Outside, at the south end of the shop, is a 33ft. electric traverser, beyond which is a 6-ton electric Goliath crane of 75ft. span, extending over the "heavy" storage space. Next to a tank shop, 104ft. by 35ft., is a light hand traverser, serving the wheel storage sidings. At the north end are an engine weigh-bridge, an examination house, and a scrap yard. On the east side is the boiler-house, containing two Lancashire boilers, with automatic stokers, for heating the shops. The old high-level erecting and wheel shops are being converted into modern boiler, boiler-testing, and tube-repairing shops, with two 25-ton overhead electric cranes in the boiler shop and a 2-ton overhead hand crane in the tube-repairing shop. Use has been made of the old boiler shop to extend the foundry, which has a 10-ton overhead electric crane, and also to form a new copper and tinsmith's shop, a department which was formerly on the low level. Part of the old high-level machine shop has been converted into a carpenters' and pattern-makers' shop, the remaining portion being used for the pneumatic and hydraulic power plants, power sub-station, and general office stores. Four views of the reorganised works are reproduced herewith.

Railway and Road Matters.

IT is suggested that the policemen who have been retained to control the street traffic signals in Ludgate-circus are about to be withdrawn, because of the success which has attended other street signal installations in the City, where such supervision has not been provided.

IN the report by Colonel Anderson, mentioned herein on July 22nd, on the collision of April 11th, at Victoria East Junction, Manchester, some particulars were given as to the amount of work done during an hour in the signal-box at that point. Between 8 p.m. and 9 p.m. on a typical Monday, there were five light engines, nine passenger trains, eight empty carriage trains, and seven freight trains signalled, and between 8 p.m. and 8.42 p.m. there were twelve shunting movements.

FROM the evidence given on July 26th at the adjourned inquest into the death of the driver killed in the Scarborough miniature railway accident on July 10th, it appears that the train movements were regulated by telephone. The superintendent said that he gave orders for one of the trains to wait, but the guard said he was told by the telephone operator not to wait. The jury returned a verdict of "Accidental death." They considered that there had been negligience, but, owing to the conflicting evidence, they could not allocate the blame.

WHEN the Labour Party has its annual Conference at Leicester in October, it will consider a report advising the establishment of a National Transport Board. It is not contemplated, the report observes, that it will be possible to bring every section of transport immediately under national ownership, but it should be possible to provide for the taking over forthwith of the railways and the long-distance road passenger services. It is further remarked that "it must be a primary object in any publicly owned industry to give the workers the fullest share in its organisation compatible with effective service in the nation."

A CABLE from the New York correspondent of the *Manchester Guardian*, under date July 22nd, mentions a plan put forward by the Inter-State Commerce Commission for the amalgamation into one concern of the four great systems in the Eastern States. The message says that "Neither the railway heads nor the financiers believe that the plan is ever likely to be consummated, and both see what great difficulties would arise if it were." We mention this because the Transportation Act, 1920, did not, like our own Railways Act of 1921, make grouping of the United States railways compulsory; it only commended it and said it was to be in accordance with a plan to be approved by the Commission.

WE have received from the American Railway Association a copy of Bulletin No. 1 of the Joint Committee on Railroad-highway Grade Crossing Protection. The Committee has recommended certain standards and methods for general adoption and the recommendations are accompanied by thirteen illustrations. The foreword offers the assistance of the Committee to any association interested in the subject. Apparently the bulletin is issued free of cost. That this or some other body has done good service is indicated by some figures in a supplement. These figures show that the casualties at grade crossings have gradually been brought down from an average of 4·17 per 10,000 registered cars in 1924 to 2·60 in 1930. The address of the Association is Transportation Building, Washington, D.C.

THERE are two types of express goods trains on the London, Midland and Scottish. One is known as "Fitted freight No. 1," and its loading is limited to forty-five wagons, all of which must be fitted with, or piped for, the vacuum brake. At least one-half of the train must have the brake complete and whilst the remainder may be marshalled irregularly, those next to the guard's brake must not be more of the pipe-only than one-quarter of the whole train. The latter requirement is to ensure uniformity of brake application. The wagons must have screw couplings and oil lubrication. There are now twenty-six such trains. The other type is "Fitted freight No. 2," whose loading is limited to fifty wagons. It has to have one-third of its wagons braked. Of this class there are forty-five trains.

THE Ministry of Transport railway statistics for the month of April have now been issued as a Stationery Office publication, price, post free, 2s. 7½d. In making any comparison with the corresponding figures for 1931 it must be remembered that Easter fell in April last year, but in March this year. That, for instance, accounts, in part, for a fall of 5·9 per cent. in the number of passenger journeys made in April, 1932, when compared with April, 1931, and of 20·7 per cent. in the receipts from passengers. Passenger train mileage was, however, slightly higher—by 0·4 per cent. The tonnage of the goods carried dropped by 3·2 per cent., and the receipts therefrom by 6·7 per cent. Goods train mileage was reduced by 0·9 per cent. and the average train load fell from 127 to 122¼ tons, but the net ton-miles per engine hour rose from 451¼ to 453¼.

THE mention of level crossings in the report of the Committee on Road Signs has led to many adverse criticisms on the subject in the Press. It has, for instance, been said that they are a peril to life and limb. The recently issued annual report of Colonel Mount shows that 154 accidents occurred at level crossings last year, in thirty one of which there were personal casualties resulting in fifteen deaths and injury to thirty-three. Of the fifteen killed, ten were occupants of road vehicles, three were pedestrians, and two were railway servants. Of the thirty-one cases of personal injury, four were due to the pedestrian's own fault; seventeen to want of caution by the drivers of road vehicles; three to breaches of regulations by gatekeepers; in one a signalman was at fault; and in six the fault lay with the trainmen or station staff. As the Road Signs Committee's report records that there are 3000 level crossings, the proportion at which there are accidents is very small. On the general question of level crossings it should be remembered that everyone has been specifically sanctioned by Parliament, and that, for some time, there has been a Standing Order that every proposal for a level crossing shall be investigated by one of the railway inspecting officers.

Notes and Memoranda.

IN a short note in the *American Machinist* Mr. J. S. Hoffman suggests that it may be preferable to plate, with chromium, sheet metal articles in the form of blanks, rather than after they have been fully shaped. The blank is easier to clean and secures a more even coating of plating, while chromium will withstand the subsequent operations without hurt.

THE journal of the British Wood Preserving Association has just appeared in its second annual edition, and is full of most useful and interesting information. Its information covers many of the processes which help towards the continuance of the "life" of timber after it has been felled and put into use. It may be obtained from 166, Piccadilly, W. 1, at the price of 7s. 6d.

A PROCESS for the electro-deposition of tin has been worked out by J. J. Collins and is described in the *Chemical Trade Journal*. It is carried out by using a molten electrolyte of anhydrous stannous chloride, and at a temperature of 270 deg. Cent. A carbon anode is employed, and the article to be plated forms the cathode. The temperature being above the melting point of tin, the metal is deposited in a molten state. The voltage used is 0·75 volt for a current density of 75–100 ampères per square foot, with a higher or lower voltage if a higher or lower current density is required.

A REPORT just issued by the United States Interior Department describes two power sites and one combination power and storage site on the stretch of the Snake River, Wyoming, between Jackson Hole and Alpine. At the upper site it would be possible to store 610,000 acre-feet with a dam 210ft. high. Of this storage, 470,000 acre-feet would be available in the upper 70ft. of the site, and the use of this water through an average head of 434ft. at the three sites would increase the potential power available for 90 per cent. of the time from 47,000 to 69,000 H.P., and the power for 50 per cent. of the time from 72,000 to 90,000 H.P.

A VARIETY of plasticised cellulose acetate is sold in America under the trade name "Lamarith." Lack of brittleness is one of its outstanding characteristics. It has a dielectric strength of 400 to 600 volts per mil. It can be ignited by holding in a flame, but it will not support combustion after the flame is removed. It can be made crystal clear and a sheet 0·0035in. thick will transmit 80 per cent. of the ultra-violet light in the sun's rays. It can be made into the clear or coloured transparent foils which are so popular as a wrapping material. It is unique in that the laps can be sealed to give a joint as strong as the rest of the foil merely by moistening it with a cellulose acetate solvent.

EXPERIMENTS on internal combustion in engines, made in various laboratories for the purpose of learning more about the nature of detonation, were discussed by H. K. Cummings, of the U.S. Bureau of Standards, at a recent aeronautical meeting of the American Society of Mechanical Engineers in Buffalo, U.S.A. These experiments indicate that a narrow combustion zone proceeds from the spark plug at a rate depending on engine speed and carburetter adjustment and that detonation usually does not occur until this burning zone has nearly crossed the combustion chamber. In the event of detonation the remaining portion of the charge, which is already heated and highly compressed, burns with extreme rapidity. This rapid burning of the last portion of the explosive charge probably is due to compression and temperature rise and to chemical actions which have taken place during the compression of the charge. The only known effect that adding tetraethyl lead to a gasoline has on combustion is to prevent the ultra-rapid burning of a portion of the charge and the accompanying abrupt pressure rise which constitute the knock. Precisely how this is accomplished has not been established as yet.

THE Forest Service of the United States has developed a simple form of hygrometer or moisture content indicator which forecasts the probability of forest fires. The instrument consists of a perforated brass rod a foot long, containing a strip of rattan attached to a hand on a dial. Rattan has a peculiar quality of elongating rapidly when exposed to moisture. The dial hand of the hygrometer, controlled by the lengthwise swelling of the rattan strip and by a tension spring, indicates the percentage of moisture. Thrust into the litter or duff on the ground under trees, this instrument gives accurate readings of the percentage of moisture in much less time than the old method of drying and weighing samples of duff. The probability of fires starting and spreading rapidly is related directly to the moisture content of the forest ground litter, so that forest officers equipped with these instruments may be warned of dangerous conditions and take necessary fire prevention precautions. In Northern Idaho, forest workers found that a duff hygrometer reading 25 per cent. moisture content for the duff, means it will scarcely burn at all, while a reading of 10 per cent. or less indicates danger of high inflammability.

AT the recent Summer Convention of the American Institute of Electrical Engineers, held at Cleveland, Ohio, many papers were presented relating to the vibration, fatigue, and stress-strain characteristics of transmission line conductors. In one paper new types of conductors are advocated which will resist more successfully than ordinary sections vibration and the tendency to fail owing to fatigue. The most favoured shapes are the twisted triangle, the twisted square, and the three-strand wire. In nearly all recorded cases, breakage of strands has occurred adjacent to a support or at a joint which had either been improperly designed or applied. A method therefore which prevents any sharper bending of the conductor at a support or joint than occurs at the middle of a loop should eliminate breakage due to vibration. After a long series of experiments the Aluminium Company of America evolved a system for the protection of conductors against vibration in the form of "armour rods." The armour consists of a spiral layer of small round rods twisted around the cable for a short distance in the same direction of lay as the outside strands of the cable. Attachment of the line conductor to the insulators is made in the centre of the armoured length.

Miscellanea.

WORK has been started on the construction of a new bridge across the Tees at Middlesbrough. The bridge is being built by Dorman, Long and Co.

PROFESSOR PICCARD is making arrangements to surpass his feat of rising in a balloon to a height of 10 miles. He proposes shortly to make the attempt near Zürich.

SUCCESSFUL experiments have been carried out in sending fish, meat, and other perishable goods by rail from Liverpool to Billingsgate packed in solidified carbon dioxide.

THE price of mercury has, so the *Chemical Trades Journal* says, dropped to £10 for a flask. Such a price should encourage those who are interested in binary-fluid power plants.

THE Great Western Railway Company has brought into service at Cardiff docks a device called the "Norfolk Spade," for pushing coal out of wagons. It will chiefly be of service in tipping wet duff, especially in winter.

IN the construction of the new post office at Pittsburg, U.S.A., some girders as deep as 10ft. 6in. by 50ft. long have been used to carry railway tracks and ten storeys of the building. Each of them weighs about 30 tons.

A NEW booklet describing the process of making a dustless, coloured, and polished concrete floor has just been issued by the Cement Marketing Company, of Tothill-street, S.W. It is said that this surface is less expensive than terrazzo.

A FIRE-FLOAT, 40ft. long, which has just been made for the Vickers-Armstrong yard at Barrow-in-Furness, was delivered from the Greenwich works of Merryweather's, by road. She is capable of delivering 1000 gallons of water a minute for fire-fighting purposes.

A FACTORY building has been put up in New York to a height of nineteen storeys. The object is to provide many small manufacturers with single-storey factories fronting on what is described as a "vertical street," that is to say, a lift well. The building provides a total of 1,800,000 square feet of floor space.

WITH the object of providing the maximum amount of natural lighting for a warehouse, which is now being built in Nottingham, the main supporting members are arranged some 7ft. back from the frontage, and as a consequence practically the whole of the face of the building is available for glazing.

THE War Office announces that Colonel W. G. S. Dobbie, C.B., C.M.G., D.S.O., has been appointed Commandant of the School of Military Engineering, Chatham (also Inspector of the Royal Engineers and Commanding Chatham Area and Depôt, Royal Engineers), with effect from February 18th, 1933.

THE two new latest Marconi beacon stations are those at Shaweishan Island, near the mouth of the Yang-tse-Kiang, and Gutzlaff, also on the important shipping routes to Shanghai and the Yang-tse-Kiang, which will be fitted with beacons of 700 watts and 500 watts power respectively. The apparatus will be specially designed and constructed for use under tropical conditions.

IN order to effect economies in the production of pig iron for the foundries, the Staveley Coal and Iron Company, Ltd., has built and put into commission two new cupolas of the balanced blast type developed by the British Cast Iron Research Association. In comparison with the older internal diameter cupola, the operation of smelting is quicker, and a saving in labour costs is effected.

THERE have recently been installed at Middlesbrough docks, thirty-seven large electrically operated cranes. The cranes, which were built by Cowans, Sheldon and Co., Ltd., of Carlisle, for the L.N.E. Railway, are electrically equipped by the British Thomson-Houston Company, Ltd. They are of the level luffing type, thirty-three having a lifting capacity of 3 tons each, the other four having a lifting capacity of 5 tons each. The cranes are to replace a number of old electric cranes, with a smaller range and lifting capacity.

THE Dominion Bureau of Statistics at Ottawa has issued its finally revised statistics on the output in 1931 of metals of the platinum group, indicating that 91,693 fine ounces of platinum, palladium, rhodium, iridium, and ruthenium, valued at 2,814,617 dollars, were produced from Canadian ores in 1931, as compared with 68,116 fine ounces, worth 2,439,128 dollars in 1930. During the year 14,202 oz. of platinum, valued at 1,135,388 dollars (contained in concentrates or in other forms), together with 81 oz. of scrap, valued at 2070 dollars, were exported. Of these concentrates, 13,528 oz. went to Great Britian, 672 oz. to Norway, and 2 oz. to the United States.

THE Laurence J. Kettle Premium will be awarded by the Council of the Institution of Civil Engineers of Ireland at intervals of one year, the funds being provided by the gross income from the gift to the Institution made by Laurence J. Kettle, member. The Premium will consist of a monetary prize and the Laurence J. Kettle Medal, and will be offered for a paper or thesis on a subject selected by the President of the Institution to be announced at the annual general meeting. The candidates shall be either associate members or students of the Institution of Civil Engineers of Ireland, and shall not be more than thirty years of age on the first day of January in the year in which the Premium is to be awarded.

THE output of crude coal tar products in America during 1931, as compared with that of 1930, shows a considerable reduction, as follows:—Benzole, crude and refined, 14,772,297 gallons in 1931 (19,142,910 gallons in 1930); benzole, motor, 61,960,025 gallons (101,862,692); creosote oil, including distillate in coal tar solution, 16,291,598 gallons (25,679,882); light oil, crude, 122,529,148 gallons (178,325,952); light oil products, unspecified, 4,163,028 gallons (6,475,725); naphthalene, crude and refined, 7,622,929 lb. (12,640,102 lb.); phenol, 94,097 gallons (136,971); pitch, 78,983 tons (106,334); solvent naphtha, including xylene, 5,800,754 gallons (6,118,298); tar, 450,856,092 gallons (602,485,929); toluene, crude and refined, 11,832,932 gallons (11,833,202).

LAUNCHING CATAPULTS FOR AEROPLANES

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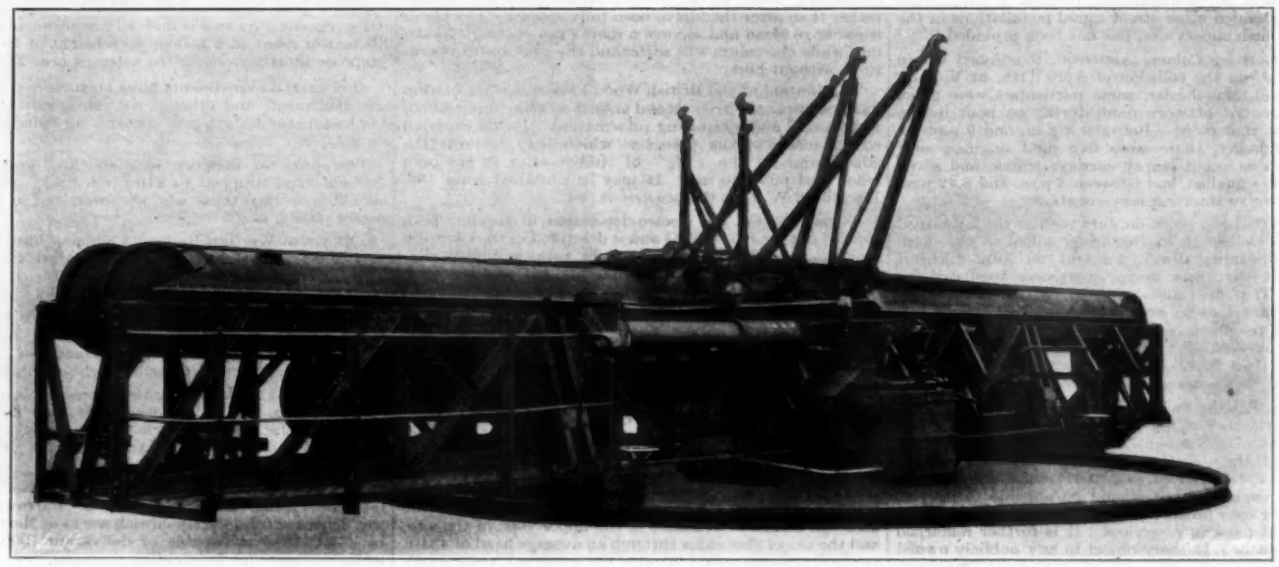
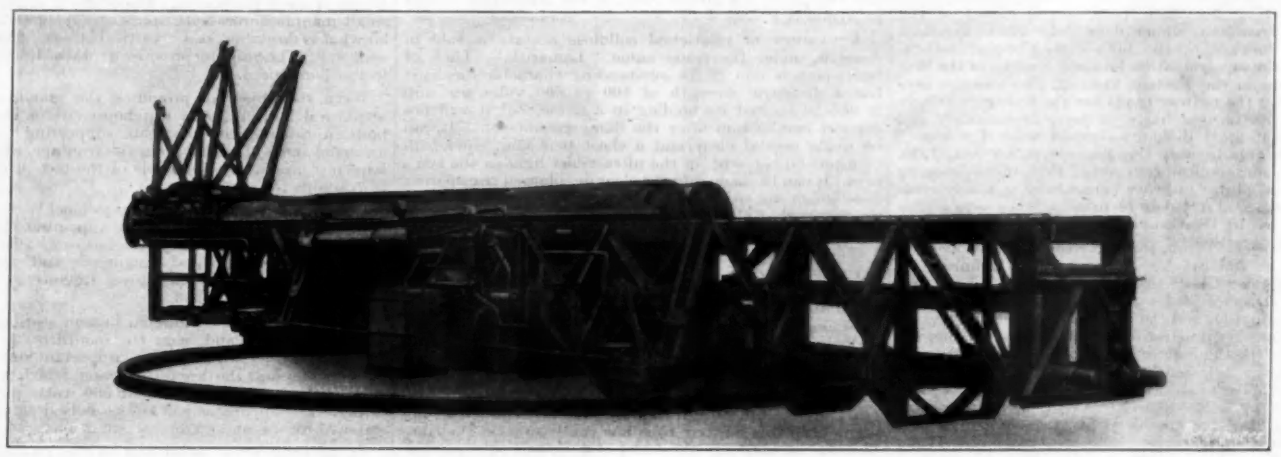
(*For description see page* 132).





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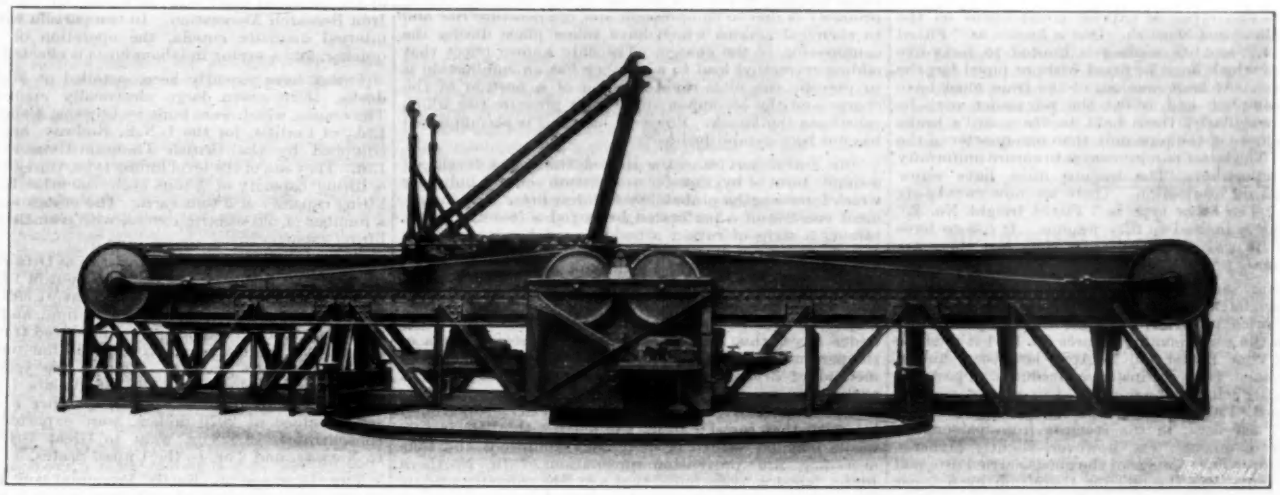

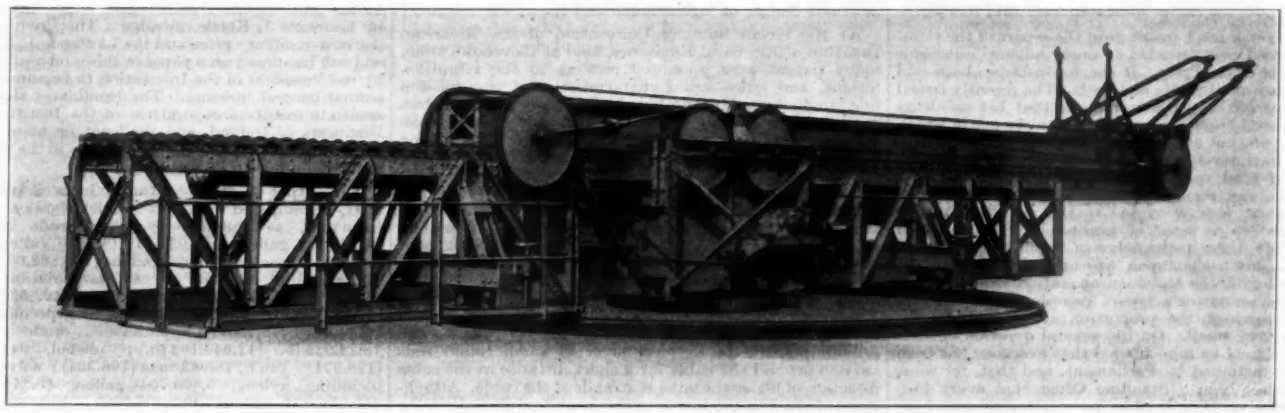

HEAVY TYPE CATAPULT IN THE STOWED AND FIRED POSITIONS

The Engineer

AUGUST 5, 1932.

VOL. CLIV. No. 3995

Contents.

THE ENGINEER, August 5th, 1932. PAGE

A SEVEN-DAY JOURNAL .. 125
STATIC BALANCE OF A SHAFT WITH SKEW STIFFNESS. (Illus.) .. 126
THE ECONOMICS OF URBAN ELECTRIC RAILWAYS. No. III. (Illus.) .. 127
CENTENARY OF THE LEICESTER AND SWANNINGTON RAILWAY. (Illus.) .. 128
THE MECHANICAL DESIGN OF ROTATING ELECTRICAL MACHINERY. (Illus.) .. 130
AEROPLANE LAUNCHING CATAPULT. (Illus.) .. 132
AMERICAN ENGINEERING NEWS .. 133
SIXTY YEARS AGO .. 134
MODERNISATION OF THE G.W.R. WOLVERHAMPTON LOCOMOTIVE WORKS. (Illus.) .. 134
RAILWAY AND ROAD MATTERS .. 135
NOTES AND MEMORANDA .. 135
MISCELLANEA .. 135
LEADING ARTICLES—
Production and Distribution .. 137
Mare's-nests and Thermo-dynamics .. 137
OBITUARY—
Sir William Wilcocks—Sir James Williamson .. 138
PROPOSED NEW OCEAN PORT FOR NORTH CHINA. (Illus.) .. 138
LITERATURE .. 139
BOOKS RECEIVED .. 139
A LARGE CONDENSING PLANT. (Illus.) .. 140
SAFE AND OVERLOAD INDICATOR FOR CRANES. (Illus.) .. 140
A NEW AIRLESS INJECTION OIL ENGINE FOR INDUSTRIAL USE. (Illus.) .. 140
MAGNETIC VALVES FOR TEMPERATURE CONTROL .. 141
PIN RIVETING. (Illus.) .. 142
TRIAL RESULTS OF THE "WHITE" COMBINED STEAM ENGINE .. 142
PLATE TYPE AIR HEATERS .. 142
RAILWAY "EFFICIENCY" .. 143
PROVINCIAL LETTERS—
The Midlands and Staffordshire .. 143
Lancashire .. 143
Sheffield .. 144
North of England .. 144
Scotland .. 145
Wales and Adjoining Counties .. 145
CONTRACTS .. 145
CATALOGUES .. 145
LAUNCHES AND TRIAL TRIPS .. 145
CURRENT PRICES FOR METALS AND FUELS .. 146
FRENCH ENGINEERING NOTES .. 147
BRITISH PATENT SPECIFICATIONS. (Illus.) .. 147
FORTHCOMING ENGAGEMENTS .. 148

NOTICES TO READERS.

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PRODUCTION AND DISTRIBUTION.

IN his conversation with the Brobdingnagians, Gulliver was told by the King that "who ever could make two ears of corn or two blades of grass grow on a spot of ground where only one grew before, would deserve better of mankind and do more essential service to his country than the whole race of politicians put together." It may be safely assumed that in this famous passage Swift meant to extol the merits of increased production, but it must not be overlooked that the comparison is made only with "the whole race of politicians," of whom he held anything but a high opinion. However that may be, the principle has been universally accepted, and the world has not stinted its praise of those who have shown it how to increase, not only agricultural, but all sorts and kinds of products. So successful have researchers, inventors, engineers, and undertakers been that at this day production and the capacity of production have outrun the demand, and we may justly suppose that a modern Brobdingnagian would modify the apothegm of his predecessor, and assert that "he who can make two ears of corn or two blades of grass be consumed where only one was consumed before would deserve better of mankind and do more essential service than the whole race of engineers." It will be observed that we have raised the standard; that we have put it on a pinacle, for the only man who can do better in these times than the engineer himself is the man who can sell the illimitable products of his skill.

It may be said without much fear of contradiction, and with a few exceptions, that the problems of rapid production have been completely solved. No person in the world need go without what he wants because enough of it cannot be made to meet the requirements of everyone. We hear of the wheat of one year so filling the silos that there is no room left for the harvests of the next; the odour of burning coffee dumps spreads over Central America; a great financial organisation purchases redundant shipyards in order to destroy them; and a body, constituted on the same plan, contemplates the closing of steel works. The capacity of our collieries exceeds by far the requirements of the country, and oil is sold in British harbours for a fraction of a penny. These excesses are not due to the industrial depression. They are the result of the skill and knowledge which have overcome the difficulties of rapid production, and to the astonishing increase—as, for example, in Russia—of factories and mines. The capacity of the world, as a whole, to produce all ordinary things has outrun its ability to consume them. The problem is no longer how to make fast enough, but how to get rid fast enough of all that we can make. America thought she had found the solution. She developed the system of deferred payments up to its limit, and paid high wages so that her workers might have the wherewithal to meet their commitments. There was an economic fallacy somewhere in the argument, for the system collapsed with more disastrous results than if it had never existed. Yet on the face of it the plan was a rational one. It was the greatest experiment in the art of distribution that has ever been made, carried out in a self-contained community, and for some years worked so smoothly that there seemed to be no reason why it should not continue indefinitely. A constantly augmenting market should have presented itself; for the more people employed, the more there were to buy, and the plan should have gone on and on until everybody had all that he could want. That was the theory. In fact, the whole scheme was too like perpetual motion; it seemed to work itself, with the usual result. There were many in America who looked askance upon deferred payments, and foretold the crash which actually occurred. In this country, and indeed in Europe as a whole, it has never found much favour, and has only been practiced with careful circumspection. Whether it will ever be allowed to attain on the other side of the Atlantic the proportions which it had reached a few years ago, is a matter for considerable doubt. There is still greater doubt that it will ever sweep this country as it swept the United States, and involve a great proportion of the country in debts or mortgages.

The failure of a system which promised so much leaves the world with no concise plan for the distribution of products on the enormous scale which can alone make possible the full economy of mass, or even quantity, production. We are therefore driven back upon the older and safer plan of making the capacity to produce equal to the probable demand. That is the direction which affairs are taking in this country, partly under the compulsion of lack of orders and partly voluntarily as by the closing of redundant factories. But, since to secure the greatest economy of production and the lowest price, large outputs are in many cases essential, it is desirable that a very broad view of the problem should be taken. The Conference at Ottawa presents an invaluable opportunity for so doing. The Empire is capable of producing all, or nearly all, its needs, and it presents a market sufficiently large to consume enough to allow production to be conducted on an economic scale. But if every member of the Empire endeavours to satisfy its own internal requirements, none of the units will reach the greatest economic capacity. On the other hand, if agreements to concentrate certain industries in certain countries are adopted, it will be possible for each one to reach a magnitude permitting the lowest cost of production. Whilst national aspirations must inevitably make the complete realisation of such a logical scheme extremely difficult, we foster the lively hope that initial steps, at least, may be taken towards a "consummation devoutly to be wished."

Mares' Nests and Thermo-Dynamics.

WAS there ever a field so prolific of mares' nests as the science of thermo-dynamics? It has but two laws, each expressible in words of infantile simplicity, yet capable of being more thoroughly misunderstood than almost anything on earth. Nearly every day one comes across examples. From the eminent F.R.S. who publishes books in refutation of Carnot's Theorem to the humbler enthusiasts who devise ingenious but impossible heat engines, there is a chain of incomprehension which seems to defy all reason. Some of its members deplore the high latent heat of steam—its most valuable thermo-dynamic property. Others, following a kindred line of thought, look on the condenser as an evil thing. An engine, for them, should be made to turn all the heat given to it into useful work, whatever Carnot or the Second Law of Thermo-dynamics may have to say about it. A publisher has been found for a recent and expensive book on steam, in which the author devotes considerable space to the advocacy of compressing the exhaust steam from a turbine so as to do away with condensers altogether. But the ambition of most inventors is to obtain power by drawing on the inexhaustible stores of heat in Nature. We do not refer to those who would drive engines, for example, by the heat of the sun in the desert, because, given enough sun and enough desert, nothing but the capital cost of the plant need prevent them from supplying the wants of the desert industries. Nor is there anything, theoretically, to prevent power being developed from the warm surface water of the tropical seas, though the arithmetic of it is sufficient to give an idea of its commercial impracticability. Geysers, or, at any rate, natural steam jets, have, we believe, been harnessed; but their potentialities are too small and too local to be of general interest. Volcanoes afford a more spectacular source of energy, but here, again, their exploitation may be left to the communities who are fortunate, or unfortunate, enough to live round them.

To those inventors who would derive power from any of the sources we have mentioned, we can only wish success, without, however, much hope that they will realise it. As for the other army who seek for something where there is nothing to be got, though they were braised in a mortar their foolishness would not depart from them. Their happiest hunting ground is the atmosphere, whose heat they hope to abstract. They are not concerned, as a rule, with the daily or seasonal changes of temperature, which might conceivably be turned to some useful account, but with the vast uniform stock of heat which exists in the air everywhere and always. The heat is there right enough, or the atmosphere would not exist. All that is required to use it, is to find some permanently lower temperature for our engines to exhaust into. Since Nature has not given us one, say our inventors, let us make one for ourselves. The thing can be done in lots of ways. A refrigerating machine will give us practically any temperature we like, but it hardly appeals to the expert mares' nest finder. More attractive is the idea of using some substance like liquid carbonic acid, which will draw heat from the very coldest natural atmosphere and by its evaporation will furnish gas under ample pressure to drive an engine. The principle is sound enough if Nature would only provide liquid carbonic acid. There is another and much more subtle scheme for utilising low temperatures. Air under pressure and at ordinary temperature will drive an engine, and it may readily be cooled a hundred degrees or more by its own expansion in the engine. The latter will, therefore, exhaust at a temperature far lower than that provided by Nature, so that, if we can only misunderstand Carnot's Theorem sufficiently, it will be evident that the efficiency of the engine will be increased. Does not every book on thermo-dynamics tell us that the heat which can be turned into work by an engine depends upon the range of temperature through which the latter operates?

A proposal of another kind, though similar in its hopelessness, was put forward in all seriousness at the Fifth International Congress of Refrigeration held at Rome in the autumn of 1927. The "Proceedings" of this Congress have only recently been published, and since the scheme in question has been considered worthy of being included therein, we offer no apology for making it more widely known. The author is Monsieur Emile Guarini, formerly Professor of Physics and Electrotechnics at the École des Arts et Métiers of Lima. His visions as to the end of the coal age and the production of all power from the atmosphere itself are common to all such projects and need not be discussed. They will, moreover, certainly be realised, when the machines employed function according to plan. Monsieur Guarini's machine can, apparently, work either as a self-acting refrigerator, giving, perhaps, a little surplus power to operate the brine-pump, or it may be used as a heat engine for the driving of locomotives or aeroplanes. The principle is simple and ingenious. Liquid carbonic acid is evaporated by the heat of the surrounding air. The saturated vapour at 10 deg. Cent. below zero, with a pressure of about 380 lb. per square inch, is admitted to the working cylinder. There it is allowed to expand adiabatically with the production of work. Expansion is carried on until the temperature has fallen to 78 deg. Cent. below zero. At this point 24 per cent. of the gas will have been condensed to liquid form. This liquid is extracted from the cylinder and the remainder of the gas is recompressed by the return of the piston. Since there is 24 per cent. less of it to undergo compression, it is as clear to the inventor

as anything can be that the recompression will require less power than was developed during the expansion stroke. He recognises that the dried gas will become superheated by compression, but he proposes to restore its saturated condition by injecting a little of the liquid withdrawn from the cylinder. The remainder of the liquid is pumped back to the evaporator. The inventor states, and we do not disbelieve it for a moment, that the cycle can be carried out as well with steam as with carbonic acid. One can easily calculate that dry saturated steam at 500 lb. pressure, expanding adiabatically down to a 29in. vacuum, will turn about 30 per cent. of its weight into water, so what could be more reasonable than to pump this water back into the boiler and just recompress the pure steam remaining? We suggest only two difficulties. To compress the residue of the dry steam to its original volume would require not less, but far more power than the total quantity given out during expansion, while its temperature would rise to something like the melting point of steel. Phenomena of the same nature would, of course, occur in the recompression of carbonic acid, or any other liquifiable gas after the extraction of the liquid of condensation. Nature cannot be cheated in the way anticipated. The latent heat that she gives up on the power stroke must be returned to the latent condition again during the compression stroke, or it will have to be paid for in some unpleasant way.

Obituary.

SIR WILLIAM WILLCOCKS.

If it be true that that man deserves well of his fellows who makes two blades of grass to grow where but one grew before, then should the world, and particularly the ancient lands of Egypt and Mesopotamia, unite in doing honour to the memory of Sir William Willcocks. As a civil engineer he was, and always will be, identified with the vast irrigation works which within recent years have transformed many million acres of Near Eastern desert into fruitful lands. In his opinions and plans he was frequently at variance with other engineers, and on at least one occasion his militant spirit brought him into conflict with constituted authority. Nevertheless, he was a remarkable man, and by the greatness of the works to which he set his hand he has earned a lasting place in the chronicles of civil engineering.

William Willcocks was born in India in 1852. He was one of the five sons of Captain W. W. Willcocks, an officer in the service of the East India Company. The Mutiny of 1857 placed the family, like many another, in grave peril, but in the face of great danger the father contrived their escape to safety and all, except the mother, survived the ordeal. Young Willcocks subsequently entered the Thomason Civil Engineering College at Roorkee and, passing out with high credit, he entered the Indian Public Works Department in 1872. In that service he remained until 1883, when at the age of thirty-one he left India for the first time in his life on receiving an engagement under Sir Colin Scott-Moncrieff in the Egyptian Public Works Department. He had already served under Scott-Moncrieff in India, and on Sir Colin's own admission the erstwhile pupil soon surpassed the master. In a short time Willcocks was made Inspector of Irrigation of the Central Provinces of the Nile Delta, and in that capacity began the movement which ultimately led to the abolition of the *corvée*, the system of forced labour which had long prevailed in Egypt and by which much of the construction of the Suez Canal had been accomplished. With characteristic activity he wrote and had published within six years of his arrival in the country his standard two-volume work entitled "Egyptian Irrigation."

Following a tour of duty during which he was required to ascertain the rental value of all land in Egypt for the purpose of land tax re-assessment, Willcocks was appointed Director-General of Reservoirs. It was while serving in this capacity that he began those studies which eventually led to the construction of the Assuan Dam and the Assiut Barrage. The great dam was designed to give perennial irrigation instead of seasonal irrigation to Middle Egypt and to ensure an increased supply of water that would remove the threat of failure of irrigation from the new lands that were then being brought into cultivation. Willcocks' plans were submitted in 1893 to an International Commission and with certain modifications were accepted. The contract for the work was signed in February, 1898, and within less than the stipulated five years the undertaking was completed. The dam is a mile and a-quarter long, and as finished at the end of 1902 it had a reservoir capacity of 35,000 million cubic feet. As designed by Willcocks, it had provision for the addition at a later date of an extra height of about 20ft., which addition would have doubled the storage capacity. The dam was intended to be sufficiently strong to withstand the final pressure without addition to its section. In the years 1907–1912 the original height of 130ft. was increased to 146½ft., in accordance with a scheme prepared by Sir Benjamin Baker. That scheme involved the reinforcing of the dam by means of an apron extending over the whole of its downstream face. It was not to be expected that Willcocks would agree to see doubts cast in this manner upon the stability of the original structure and its ability to withstand the additional load without alteration to its section. A hot controversy ensued on the subject between Willcocks and others—notably Sir Hanbury Brown—much of which appeared in print in our columns during the year 1913. The dam is now being increased in height for a second time.

Willcocks retired from the service of the Egyptian Government in 1897. In 1901 he was sent to South Africa to report upon the possibilities of effecting improvements in the irrigation of arid land in Cape Colony, the Orange Free State, and the Transvaal. He drew up an ambitious scheme for dealing with some three million acres of land, whereby its value would have been raised from almost nothing to about £100,000,000. The scheme was not carried out in full, but portions of it were eventually completed. For his services in connection with this work Willcocks was created a K.C.M.G.

In 1911, while serving as head of the Irrigation Department of the Turkish Government, he reported upon the irrigation of Mesopotamia. In that report he evolved a scheme which was designed to revive by irrigation the ancient fertility of Chaldea. The scheme was put into execution to the extent of constructing the barrage at Hindia, whereby an area of

SIR WILLIAM WILLCOCKS]

3½ million acres was irrigated. The outbreak of the Great War prevented the execution of the full scheme, but Sir William's maps and plans of the country proved of great value to the British Expeditionary Force which was despatched to Basra.

Following the war, Willcocks strongly attacked Sir Murdoch MacDonald's schemes for damming the Blue and the White Niles. Those schemes were reported upon favourably in 1920 by an impartial commission of engineers, but Willcocks' attack upon them had unfortunate results, coming as they did at a critical period in Egyptian history, and in 1921 he was convicted by the Supreme Consular Court of Egypt on a charge of sedition and libel. In 1926 he was induced to visit India to report upon the possibility of making use of the neglected irrigation facilities of Bengal. He drew up a scheme involving an estimated cost of £12,000,000, but although many supported it, it had to be set aside for political and economic reasons.

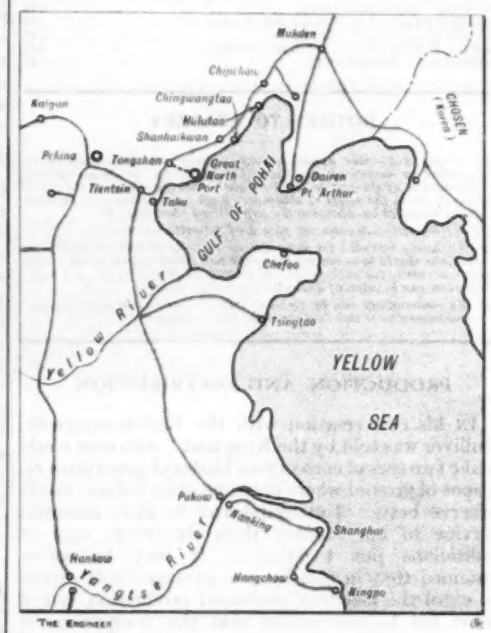
Sir William's closing years were spent in retirement at Cairo, where he died on July 28th, in his eightieth year.

SIR JAMES WILLIAMSON.

Naval architects and shipbuilders will regret to learn of the death of Sir James Williamson, for many years Director of Dockyards, which took place at his home on Saturday last, July 30th. Sir James was born on January 28th, 1839, and was educated at the Esplanade House Academy and the Portsmouth Grammar School. He entered Portsmouth Dockyard as a shipwright apprentice in 1853, continuing his training in shipbuilding and naval architecture at the Dockyard College. On leaving Her Majesty's service in 1865, he was appointed a surveyor by Lloyd's Register of Shipping, and subsequently became the society's principal ship surveyor. In 1881 he joined the administrative staff of Barclay, Curle and Co., Ltd., as managing partner of the company. In December, 1891, he was appointed by Lord George Hamilton to be Director of Dockyards on the voluntary retirement of Professor Elgar. He introduced many improvements into the dockyard service and carried out a large programme of shipbuilding and refitting. Owing to his initiative, pneumatic tools were introduced into the dockyards and electricity was adopted for the driving of machinery and for lighting, the electrical staff at the dockyards being placed on a permanent basis. In 1900 he was knighted, and in 1905 he retired on account of age. Sir James Williamson was greatly respected by his staff for his courtesy, his mastery of technical details, and the consideration and breadth of view which marked all his dealings. He had a genial personality which encouraged his staff to co-operate with him heartily in the tasks he undertook. He was a member of the Institution of Naval Architects, and in 1901 he served on the Council of that body; but he did not take an active part in the discussion of papers. Sir James was also a member of the Institution of Engineers and Shipbuilders in Scotland.

Proposed New Ocean Port for North China.

The creation of a new ocean port for North China, on the north shore of the Gulf of Pohai, is recommended in the report of the Great Northern Port Commission, which has been studying the matter for two years. This project for a deep-water ocean port, free from ice, originated with the late Dr. Sun Yat Sen, whose plans for the modern development of China as a Republic included three great ocean ports for North China, East China, and South China. The Nationalist Government organised the National Con-



POSITION OF PROPOSED GREAT NORTH PORT

struction Commission to carry out important public works along the lines of Dr. Sun Yat Sen's plans, and in 1929 this Commission appointed a Board to investigate the Great Northern Port scheme. In 1931, representatives of the Ministry of Railways and the Ministry of Communications were added to the Board, which was then reorganised as the Commission for the Development of the Great Northern Port. The first report has now been presented by Dr. Shu-tien Li, Chairman and Chief Engineer of the Commission. Extensive surveys, soundings, and commercial studies have been made, a meteorological station has been established, and general plans have been prepared for the port and its city.

The site is about midway between Taku, 70 nautical miles, and Chingwangtao, 64 miles, in longitude 118° 51′ E and latitude 39° 11′. It has the special advantage of being nearer to deep water than any of the other proposed or existing ports on the Gulf of Pohai. Its distances are 147 nautical miles from Dairen, 126 miles from Hulutao, 96 miles from Tientsin, and 160 miles from Chefoo.

While Tientsin is an important commercial centre of North China, it is situated some distance up a river, has only shallow-draught accommodation, owing to the amount of silt which accumulates in spite of dredging, and is frozen up in the winter months. The Taku bar at the mouth of the river, and about 6 miles off shore, is also a serious obstacle to ocean steamer commerce. The navigation channel inside the bar permits only a draught of 14ft., and sometimes only 10ft., so that large vessels have to anchor outside the bar. At Chingwangtao there is a pier, but it is inadequate, and that place is neither a manufacturing nor a consuming centre. What is needed is an ice-free deep-water first-class port, completely

equipped with modern facilities. Such a port can be provided near the mouth of the Lan River, and will be in a strategic position in relation to ocean and coastwise shipping, and to inland transport by rail, road, river, and canal. Further, the site is near the largest salt-producing district in China, and a rich agricultural district, and is only about 40 miles from the well-developed Kailan coal-mining district.

As the harbour is near deep sea water, there is no liability of its being frozen even during severe winters. The tidal range is about 8ft., or slightly less than at Taku. With the basin only 3¼ miles from a sea depth of 35ft., a short and easily dredged entrance channel will be sufficient to serve it. There would be little or no silting, as the tidal currents would not carry silt from the Lan River to the harbour site. The littoral currents run east to west at rising tide and from west to east with the falling tide. There are few meteorological records available, but those for 1931 showed a range of temperature from 10 deg. to 95 deg. Fah., with an average of 55 deg. to 60 deg. Fah. for the year. Prevailing winds are south-west from February to May and July to September, south-east in June, and north-east from October to January. Rainfall in 1931 was about 18in., half of it occurring in July and August. Fogs are few and of short duration, and snow is moderate in severe winters. Although the sea freezes for about 150ft. from shore, the ice is thin and may be blown out by the wind; if the fresh water from the Ta Ching River should be diverted further to the south-west, the harbour could be kept open by ice breakers, even during the severest cold.

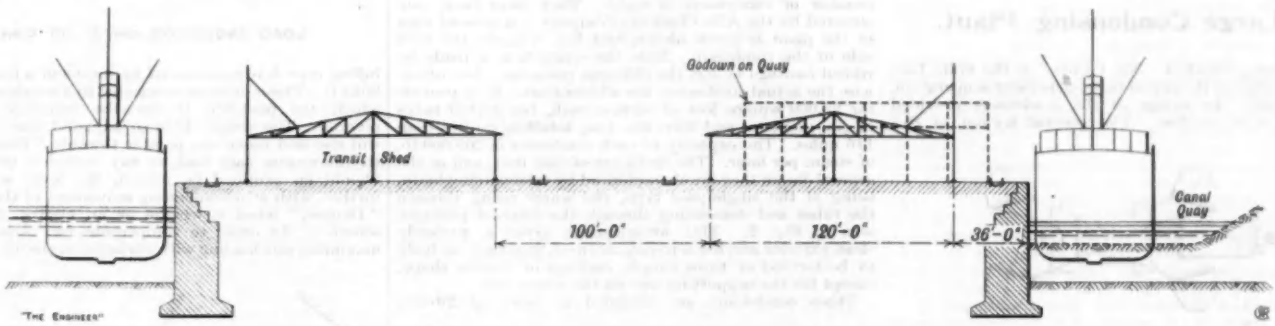
For internal communications, the first step would be a branch railway from the port to Tangshan on the Peiping and Liaoning Railway. A railway and canal to the Kailan collieries are projected, while there are numerous existing canals in the hinterland, and the Lan River can be improved so as to accommodate light-draught steamers as well as barges. Highway connections would be necessary.

Two principal engineering works would be a pier and a quay, each about 400ft. wide, composed of solid ground between massive concrete dock walls. There would be 36ft. of water on both sides of the pier and on one side of the quay, the other side of the latter having a boat canal 100ft. wide, with 10ft. of water. On the pier would be two rows of 120ft. one-storey transit sheds, 100ft. apart, with railway tracks between them and a track along each water-side of the pier. The quay equipment would be similar, except that a three-storey warehouse or godown would take the place of a transit shed on the canal side, and the only railway line would be a track along the deep-water side of the quay.

Three periods of five years each are proposed for the construction work, with expenditures of approximately £5,000,000 for each period. The first period would cover the execution of the necessary dredging and filling; the construction of the 52-mile railway to Tangshan; a 1600ft. length of pier and 3500ft. of quay, giving a total of 6500ft. of steamer berthing space; the transit sheds and warehouses; and the provision of the necessary pilot boats and tugs; also the laying out of the city and the construction of water-works and electric light plants. The other periods would cover mainly extensions and enlargements, together with such additional works as dry docks, coaling piers, oil wharves, and municipal structures.

To finance this Government project, it is proposed that port bonds should be issued for £10,000,000 to be expended in ten years. After that period, the Customs revenues and land sales should provide for the final five-year period. The report suggests also that in order to distribute the expenditures it might be economical to arrange to provide the necessary funds partly by direct appropriations from the Central Government, partly by internal bonds, and partly by foreign loans. As there are no extensive settlements or works at the proposed site, it is pointed out in Dr. Shu-tien Li's report that the development of the port and the building up of a modern city can be accomplished in an economical way and according to the best planning of engineers and architects.

A NOTICE, for October 27th, stands in the name of the Prime Minister to carry over the London Passenger Transport Bill to the next session of Parliament.



CROSS SECTION OF PIER AND QUAY AT PROPOSED GREAT NORTH PORT, CHINA

Literature.

Land Drainage. By W. L. POWERS, M. Am. Soc. Ag. E., and J. A. H. TEETER, B.S. (C.E.). Second Edition. 1932. London: Chapman and Hall, Ltd. Price 20s.

WHETHER regarded as expounding, for the engineer, the agricultural side of land drainage, and, for the farmer, the engineering side, or considered as presenting for both farmers and engineers a single subject in which the science, the data, and skilled practice in both arts are combined to provide an unexpectedly effective means of improving land, this book is the outcome of knowledge and experience for the effective combination of which the conditions in the United States are especially favourable. There are soil scientists in Great Britain, but no such society of agricultural engineers as that of which Mr. Powers and many skilled professional men in the United States are members, while few, if any, British teachers of engineering have held posts corresponding to that of professor of drainage and irrigation engineering, formerly held by Mr. Teeter at Oregon Agricultural College.

The most important of the developments which have called for the inclusion of matter additional to that of the first edition of this book is the recognition, in the United States, of the value of terracing and other means of preventing soil erosion. There are examples of such works, often in areas sharply defined by racial boundaries, in many parts of the world. The methods are such that there is little room for controversy as to their nature or purpose.

The authors include, as another of these developments in the United States, the attention given to river and flood control, but they very properly confine their presentation of such measures of control to those directly related to the subject of their book, as including land preservation. Present practice in the employment of machinery is duly described, with a brief but sufficient reference to the method of forming a ditch by means of a scarifier in conjunction with running water, the principle of which, it may be observed, may be applied in forming larger channels, especially cuts across river bends.

The revision has been carried out in such a manner as to maintain the character of the work as a drainage text-book, with the least practicable encroachment on other fields. The data and computations required for the application of the methods described are, however, more fully presented than might be expected, while a chapter on drainage surveying provides elementary instruction in surveying and levelling and the adjustment of instruments. Of the 336 pages of text and very informative illustrations, about three-sevenths are in Part I., relating to field drainage, in which the purposes and effects of soil and subsoil drainage are lucidly explained and the various works described. Part II., relating to district drainage, includes a study of law, procedure, and organisation, with a chapter on the assessment of benefits and of costs. The design and construction of open ditches are dealt with in this part, also flood and river control, mainly considered in respect of bank erosion and protection. Part III. is devoted to discussions of special problems, such as the drainage of tidal and marsh lands, and of irrigated lands, and drainage by pumping from wells.

Chapter XXII, demands individual notice, since it is a brief outline, with fifteen very helpful illustrations, of measures for the prevention and control of erosion of the soil, with special reference to terracing. The authors cite an estimate made by Mr. H. H. Bennett, of the United States Bureau of Chemistry and Soils, that plant food is removed from the land surface of that country by erosion, at twenty times the rate of its removal by crops.

The book is printed conveniently for ready reference and has a well-arranged index of fifteen pages. At the ends of the chapters there are numerous references to the literature of the subject, largely bulletins and reports from official and other sources in the United States. There is no failure, however, to give consideration to the data and practice of other countries.

The authors have repeated in this edition the achievement of providing a volume which adequately serves as a text-book for students of agriculture or agricultural engineering, and which is no less valuable as a book of reference for farmers and land-owners. For British civil engineers and for organisers of Empire development it may serve to emphasise the importance of a field of work into which the civil engineer is seldom invited, although the results to be obtained from the application of engineering skill and experience in that field are of unsurpassed importance.

A Text Book on Roofs and Bridges. Part II.: Graphic Statics. By the late MANSFIELD MERRIMAN, M. Am. Soc. C.E., and HENRY S. JACOBY. Revised by EVERETT E. EBLING, A.M. Am. Soc. C.E. Fifth edition. London: Chapman and Hall, Ltd. 1932. Price 20s.

IT is interesting to note that since the publication of the first and second editions of this familiar and highly esteemed book in 1891 and 1892, it has been possible to keep pace with developments by publishing a third edition in 1897 and a fourth in 1917; sufficiently so, in the opinion of engineers and teachers, as evidenced by the calls for three reprints of the second edition, seventeen of the third, and four of the fourth.

For the present edition the book has been rewritten and obsolete matter replaced by such as relates to practice of the present day. In accordance with systematic instruction as now given, methods of employing influence lines have been introduced earlier in the book, in Chapter III., relating to highway bridge trusses; while in Chapter IX. the influence line method of determining deflections is applied to beams and cantilevers. By the inclusion of consideration of the dead and live loadings of highway bridges of the present day and of recent data relating to railway bridge loadings, and to impact, Mr. Ebling has preserved the usefulness of a special feature of the book, the systematic presentment of solutions of stress distribution in the principal types of trusses and important modifications thereof. Such modifications, or special forms, to which reference is made include those adopted for spans of bridges described in the engineering Press in 1928, 1929, and 1930.

In the opinion of at least a few engineers who maintain an open mind in regard to the choice of types of bridges for sites of varied character and for traffic conditions, the future developments of which are unknown, the truss span has failed to receive the consideration which it deserves, in respect of programmes of bridge building in Great Britain. If that be so, the publication of a revised edition of a work which is one of value to engineers as well as to teachers, and treats adequately of the graphic statics of trusses, may be considered to be timely.

BOOKS RECEIVED.

The Calendar and its Reform. By F. A. Black. London: Gall and Inglis, 13, Henrietta-street, W.C. 2. Price 2s. 6d. net.

Railway Year Book, 1932. London: The Railway Publishing Company, Ltd., 33, Tothill-street, S.W. 1. Price 5s. net.

Modern Developments on L.M.S. Railway. London: Modern Transport Publishing Company, Ltd., 105/109, Strand, W.C. 2.

Sidestrand III. Aeroplans. London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C. 2. Price 3s. 6d. net.

Testing Radio Sets. Second edition. By J. H. Reyner. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 10s. 6d. net.

Welding and Cutting on Railways and Tramways. London: The Institution of Welding Engineers, 30, Red Lion-square, W.C. 1. Price 3s. 6d. net.

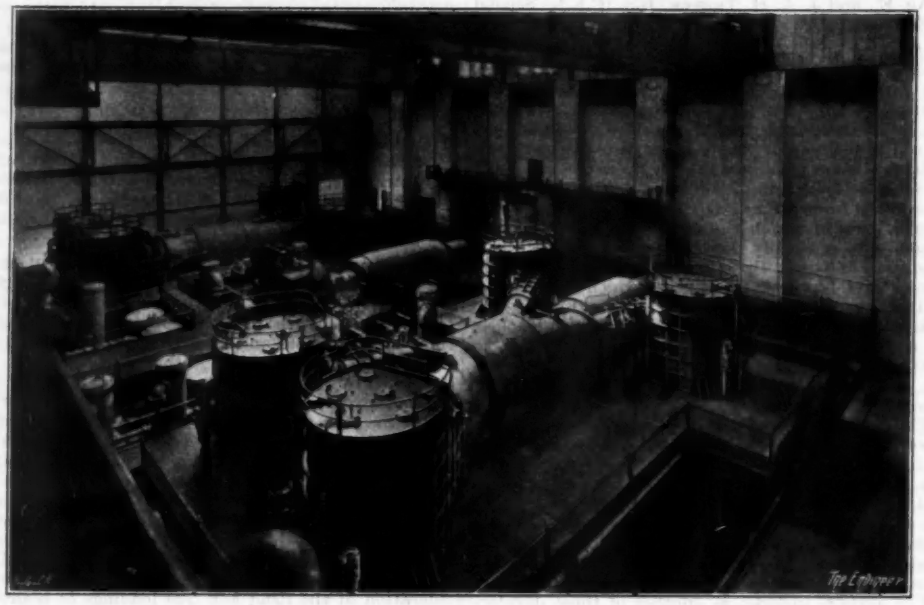
The Problem of Incentives in Industry. By G. H. Miles, D.Sc. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C. 2. Price 3s. 6d. net.

Railway and Seaport Freight Movement. By G. Bulkeley, A.M.I. Mech. I. London: Crosby Lockwood and Son, Stationers' Hall-court, E.C. 4. Price 15s. net.

Colliery Machinery and its Application. By Sir R. A. S. Redmayne, K.C.B., M.Sc., &c. Longmans, Green and Co., Ltd., 39, Paternoster-row, E.C. 4. Price 30s. net.

The Heat-treatment and Annealing of Aluminium and its Alloys. By N. F. Budgen. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 25s. net.

No. 1 UNIT, STATE LINE STATION, CHICAGO



A Large Condensing Plant.

The recently installed "No. 1 Unit" at the State Line Station, Chicago, is the largest turbo-generator in operation, and, naturally, the design of the condensers provided something of a problem. The general lay-out of this

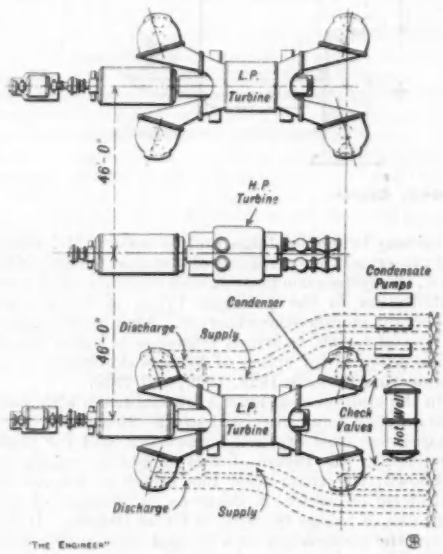


FIG. 1—GENERAL LAY-OUT OF PLANT

remarkable unit is shown in the diagram in Fig. 1, from which it will be seen that it is a three-cylinder compound. It was built by the American General Electric Company, and really consists of three machines, one H.P. set develop-

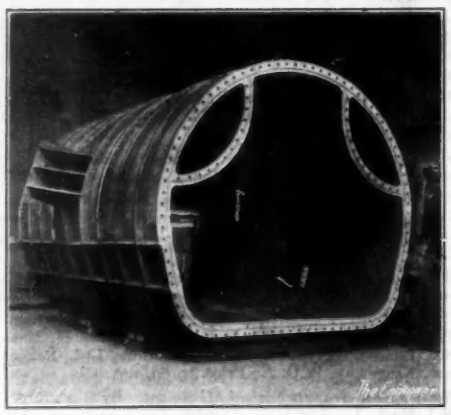


FIG. 2—CONDENSER BODY

ing 76,000 kW, and two L.P. sets of 62,000 kW capacity, the latter also driving house sets of 4000 kW. All these units run at 1800 r.p.m., with steam at an initial pressure of 650 lb. and superheated to 750 deg. Fah. The exhaust is divided at each end of the L.P. sets so that the total number of condensers is eight. They have been constructed by the Allis Chalmers Company. A general view of the plant is given above, and Fig. 3 shows the inlet side of the condenser. Here the connection is made by ribbed castings to suit the different positions; but otherwise the actual condensers are all identical. They provide for 22,000 square feet of surface each, the 38,400 tubes of ¾in. diameter and 20ft. 2in. long totalling no less than 146 miles. The capacity of each condenser is 200,000 lb. of steam per hour. The shells are of cast iron, and in the general design they are characterised by extreme simplicity, being of the single-pass type, the water rising through the tubes and descending through the internal passages seen in Fig. 2. This arrangement gives a perfectly clean exterior and leads to compactness, enabling the body to be formed of three simple castings of similar shape, except for the supporting feet on the centre one.

These condensers are designed to work at 29·3in.

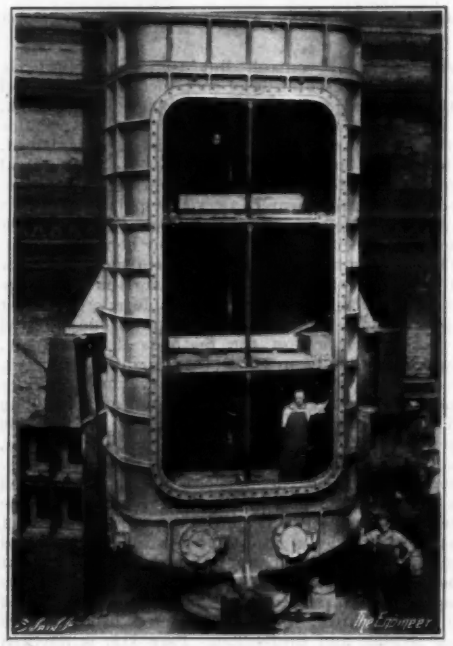


FIG. 3—CONDENSER PARTIALLY ASSEMBLED

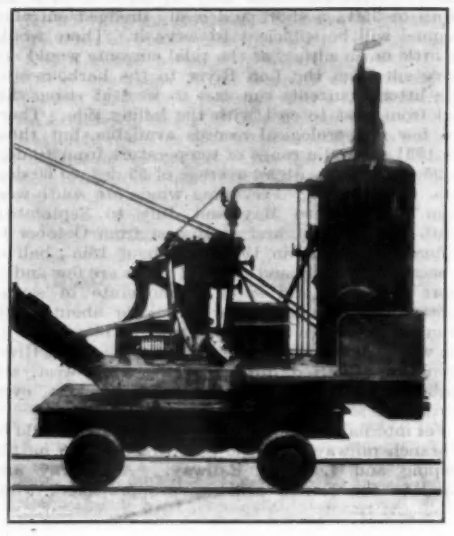
vacuum, with water at 45 deg. Fah., of which no less than 432 million gallons has to be circulated in twenty-four hours. The water connections at the base are 48in. diameter, and each circulating pump deals with 95,000 gallons per minute. These pumps are of the vertical, single-stage type, driven by 600 H.P. motors, while the condensate pumps are of the three-stage type, each driven by a 250 H.P. motor.

The air is dealt with by Evactor ejectors of the Croll-Reynolds two-stage class. Two of the first-stage ejectors are mounted on the condenser. Their discharges are interconnected for each low-pressure unit, and they supply six second-stage ejectors, with two intermediate and after coolers. With a capacity of 84,000 cubic feet of air per minute at 1in. (abs.), they consume 3900 lb. of steam per hour.

It is reported that a planter named Fitzwilliam who owns a cocoa estate near Port of Spain, Trinidad, has discovered a new source of helium.

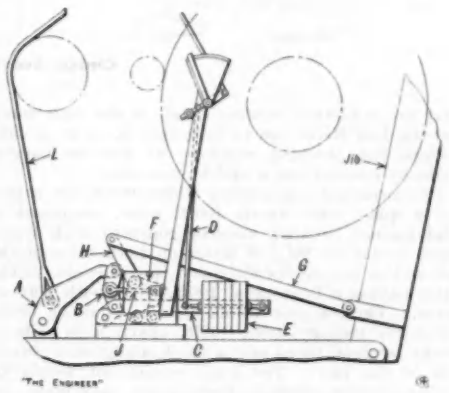
Safe and Overload Indicator for Cranes.

The large number of accidents caused by the overloading of travelling jib cranes has made it imperative that some kind of safety device should be fitted in order to warn the operator when he is attempting to lift too great a load at any radius of the jib. Herewith we illustrate the patented safe load indicator, manufactured by Thos. Smith and Sons, Ltd., of Rodley, Leeds. The load on the



LOAD INDICATOR ON A JIB CRANE

luffing rope L is transmitted by means of a lever A to the links B. These links are connected to a weighted lever C to which the push-rod D—for the indicator pointer—is pivoted. The weight E is so adjusted that the lever C will rise and move the pointer towards "Danger" when the maximum safe load at any radius is being moved. Should an overload be moved, the lever will rise still further, with a corresponding movement of the pointer to "Danger," when a whistle or an electric bell will be sounded. In order to compensate for variation in the maximum safe loading with variation in the working radius



DETAILS OF LOAD INDICATOR

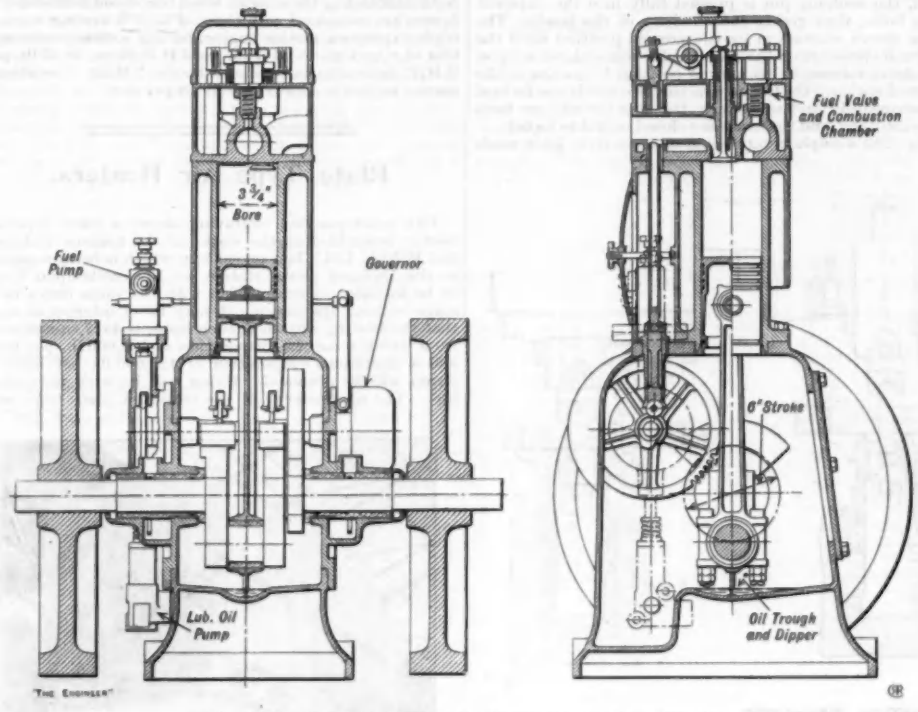
of the jib, a cam F is connected through an arm H and a coupling-rod G to the jib. This cam operates on one arm of a bell-crank lever, the other arm of which is coupled at J to the links B, the object being to vary the angle of the links B by means of the operating face of the cam F. Any variation in the angle of the links has a cumulative effect on the leverage of the system. We show above the indicator installed on a crane.

A New Airless Injection Oil Engine for Industrial Use.

We recently inspected the new X L Engine Works of Capel and Co., Ltd., at Colchester, part of which factory has been specially laid down for the standardised production of the new type of airless injection, four-stroke, compression-ignition oil engine illustrated herewith. The engine has been designed for agricultural, industrial, and electric lighting services, and will be manufactured in conjunction with the firm's existing ranges of petrol and paraffin engines for both marine and industrial uses. The new design is the result of over two years of experimental and research work, and will be manufactured for the present in four engine sizes, embracing two single-cylinder and two twin-cylinder units, with rated outputs of 5½, 8½, 11, and 17 B.H.P. respectively, all at a standard running speed of 850 r.p.m. The running parts are totally enclosed within a dustproof, oil-tight casing of cast iron, which is provided with inspection doors giving access to the bottom end of the connecting-rod, and also to the valve tappets. The crankshaft is cut from the solid and machined all over, and carries balance weights and two fly-wheels, which are also machined all over and are designed to minimise cyclical variation, giving an equal turning moment suitable for generator driving. The fuel pump, which is of the standard Bosch pattern, is

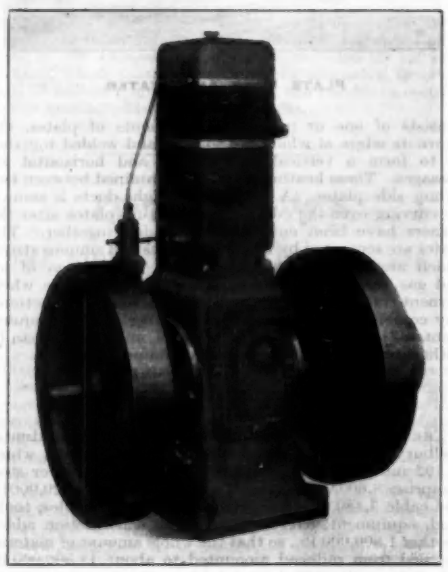
driven from a lay shaft geared to the crank shaft. The same shaft also carries the air inlet and exhaust cams and the close speed regulation governor, which proportions the delivery of fuel to the sprayers, according to the load. The governor was demonstrated to us in operation, and when the load was suddenly removed the speed of the engine did not rise by 2½ per cent. above the normal. The engine we found responded easily to the throttle control and ran very quietly at low speeds.

Attention may be called to the method of lubrication



5½ H.P. AIRLESS INJECTION INDUSTRIAL OIL ENGINE

adopted which embodies some new features. Oil is supplied to the main bearings from a lubricating oil pump driven off the cam shaft, which, in addition to feeding the main bearings, maintains a constant level of oil in a trough, forming part of the crank casing and placed immediately below the bottom end. The dipper attached to the bearing cap feeds oil to the crank bearings and at the same time throws oil on to the piston, the cam shaft driving gears, the gudgeon pin and the top end bush. In addition to the compression rings, the piston carries two scraper rings, which prevent any excess of oil passing the piston and being consumed in the combustion chamber. The absence of excess lubricating oil in the combustion chamber was clearly shown by the smokeless exhaust of



AIRLESS INJECTION OIL ENGINE

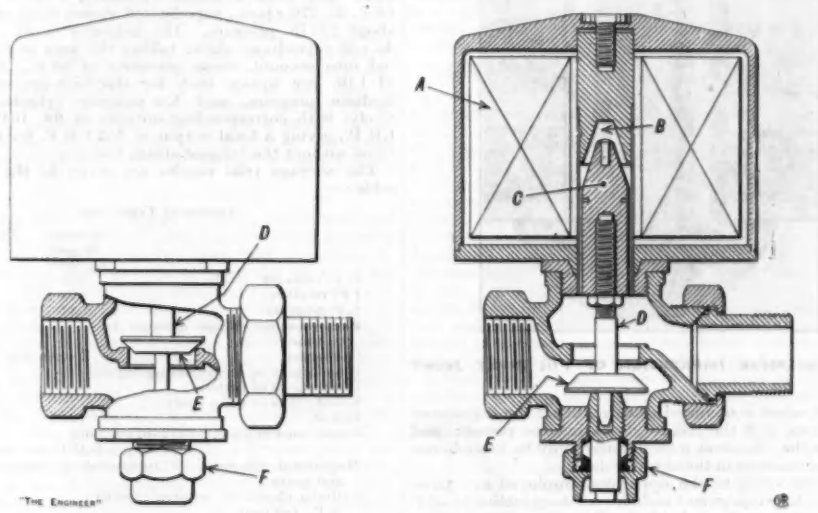
the engine during the bench trials. The cylinder head is of a simple design, and the auxiliary combustion chamber is of spherical form, with multiple openings into the main cylinder, the design of which gives an ordered turbulence and forms the subject of special patents. The push rod driven rocker gear for the overhead valves is neatly arranged on the top of the cylinder head, and is covered by a light removable casing. The valves are of chrome nickel steel and are carried in renewable guides.

The engine has been submitted to prolonged continuous tests, and has shown, we are informed, excellent results as regards power and fuel consumption, with easy starting. The compression ratio normally employed is about 15 to 1, giving a brake mean effective pressure of 97 lb. per square inch. On tests, B.M.E.P. of up to 108 lb. per square inch have been obtained with correspondingly higher engine outputs. During the time the engine was run in our presence there was an absence of combustion noise at all the speeds at which the engine was run, and the measured fuel consumption was about 0·45 lb. per B.H.P.-hour.

A non-stop test run of 103 hours was recently carried out with one of these new engines, having a bore of 3¾in. and 6in. stroke. The engine ran continuously on the brake, giving 5·1 B.H.P. at 800 r.p.m., and for a further 12 hours, with an overload of 10 per cent., giving 5·5 B.H.P. at 800 r.p.m., and, finally, for a further hour with a brake load giving 5·8 B.H.P., making a total non-stop run of 116 hours. Throughout the whole of this period the engine ran without attention, excepting the adjustment of the brake load and the supply of fuel. At the conclusion of the test, the engine, on being dismantled for examination, showed no sign of carbon deposit on the piston or the cylinder walls. The bearings, crank, and other parts indicated no sign of undue wear. The consumption, measured over the whole run, worked out at 0·45 lb. per B.H.P. per hour, Shell "Diesel" fuel oil being used, with a specific gravity of 0·88. A maximum B.M.E.P. of 84·7 lb. per square inch was registered. These figures have been checked by a series of independent trials, carried out by Mr. W. A. Tookey, M. Inst. C.E., M.I. Mech. E., of 39, Victoria-street, Westminster, S.W. 1, particulars of which have been supplied to us. The engine described marks a further addition to new all-British engines, on which Mr. J. B. Kerr, the designer, is to be congratulated.

Magnetic Valves for Temperature Control.

For the automatic control of temperature within narrow limits, the Magnetic Valve Company, Ltd., of 48, Bloomsbury-square, W.C. 1, has introduced the magnetic valve shown in the accompanying illustration. It may be used for governing the flow of steam, water, and other fluids, and it has the merit of being constructed on simple lines. When the solenoid A is energised, the magnetic field set up at the point B attracts the plunger C, and lifts the valve spindle D, thus either opening or closing the valve, according to whether the latter is mounted above or below the seat, as shown on the left and right of the illustration respectively. All the valves can be provided with a hand-regulating device, as shown, for example, at F, so that in the event of the supply of current failing, regulation can still be obtained. A special feature of the valve is the method of assembly which gives ready access to all the parts. A pressure switch, time switch, thermostat, or hand switch and various other forms of apparatus can be combined with the valve to give accurate automatic or remote control. When a D.C. thermostat is used and the loading exceeds 0·1 ampère, it is necessary to insert a relay in the circuit. Unless the solenoids are specially constructed they cannot be used on A.C., which must be converted to D.C. by means of a rectifier. If there is only one thermostat it can be connected on the A.C. side of the circuit and will carry loads up to 15 ampères.



MAGNETIC VALVE FOR AUTOMATIC CONTROL OF TEMPERATURE

The use of these valves and thermostats in connection with the central heating of buildings is claimed to result in the desired temperature being automatically secured and the elimination of waste of fuel. The scheme is also applicable to cooling systems. Where silence is required, the valves may be fitted with a special rubber seating, whilst where the pressure does not exceed 40 lb. per square inch, and a small orifice will suffice, a needle type valve may be employed. For pressures higher than those for which the ordinary stop valve and needle valve are suitable, the firm supplies a "servo" operated stop valve, in which a full-bore orifice is opened and closed by a piston-operated valve head, the piston being actuated by the pressure of the controlled fluid subject to the operation of a small magnetic valve contained within the main valve body. The various types of valves made are used in connection with water and low-pressure steam heating systems, refrigerators, condensers, calorifiers, pasteurisers, vulcanisers, air heaters, Turkish baths, &c.

The magnetic valve control system has been adopted for controlling the operation of oil burners, so that the oil, air, or steam may be shut off in the event of the limits of pressure or temperature being reached, and the system is claimed to afford a positive safeguard against dangers resulting from the extinction of the flame or the failure of the electricity supply. By means of the system oil can also be maintained at a constant temperature in order to secure uniformity of flow. Various types of valves are supplied for use on oil fuel installations, including an ordinary stop valve fitted with a by-pass.

For the control of gas passing through pipes the diaphragm type of valve is recommended. The valve consists of a specially treated leather diaphragm supported by a plate to ensure a seating when the valve is closed. The outer edge of the diaphragm is fixed between metal rings and the opening and closing of the valve is obtained by the movement of the leather. It is claimed that the diaphragm prevents any foreign substance in the gas or pipes working up into the parts of the magnetic valve. The valves can be supplied with an adjustable by-pass to allow the constant passage of a specific amount of gas, and a hand adjustment can be fitted to enable the volume of gas passing through the main valve to be regulated to a definite amount. The valves are supplied either for electrically opening or closing. Where gas is controlled by an automatic device, it is essential, in order to avoid danger as the result of the escape of unburnt gas, either to provide a by-pass or a constant means of ignition. In certain cases hand control mechanism may be fitted, so that when closing has occurred the valve will not reopen of its own accord, but must be operated by hand. In general, the types of valves used for water and other fluids are employed for controlling the flow of steam, although modifications of these valves to suit any particular plant or process may be made. Magnetic valves for saturated or superheated steam or for working under vacuum are available.

A development of the magnetic valve control system is the "modulator," which in effect is a temperature-reducing valve for water and steam. In a thermal storage installation, where water is stored at a much higher temperature than that at which it is required to be used, the apparatus will maintain a predetermined temperature in the distribution pipes, so long as the initial temperature is equal to or higher than the temperature required. It may be desired to supply high-temperature water to a radiator system and low-temperature water to a panel system from one set of boilers or calorifiers, and the modulator is designed to meet these requirements. In a similar manner heating and hot water supplies may be derived from one central source, and under these conditions the system is particularly advantageous where oil fuel is used, for only one burner need be employed. By the use of the modulator and the introduction of a calorifier for the domestic supply, the central heating boiler may be used to operate the two

systems, the burner controls being set to maintain a temperature in the boiler sufficiently high to heat the domestic water supply passing through the calorifier, whilst the temperature of the water supplied to the heating system is regulated by the modulator to meet climatic conditions.

Pin Riveting.

A system of riveting steam boilers which, we believe, is new to this country, has recently been brought to our attention by Daniel Adamson and Co., Ltd., Dukinfield, who are the licensees for the process from the Skoda Works, Ltd., Prague. With this new system, instead of using shanks with a pre-formed head as hitherto generally adopted, plain lengths of rivet steel cropped from a bar are used, the two ends of the blank being upset equally into the holes in the plates, so that both countersinks of the holes are filled up and both rivet and head are closed simultaneously. With this system of pin riveting the blanks are heated up uniformly throughout their whole length, thus requiring lower static pressures, far below the yield point of the plates. This feature tends to greater safety, as the plates are stressed much less than when the rivets are pressed in, and the danger of the molecular coherence of the plates being disturbed is avoided. With pin riveting, the two heads being formed simultaneously and uniformly from both sides, an absolutely tight filling up of the holes is ensured. The system is also claimed to have other advantages. One is that no oxide is formed on the rivet, which enables a clean metallic contact to be made between the rivet head and the plate; a second is that the necessity for caulking the rivets and the plate edges is obviated, thus reducing the expense of manufacture and the risk of damaging the plates; and a third is that the rivet material need only be heated once instead of twice, as in the older method.

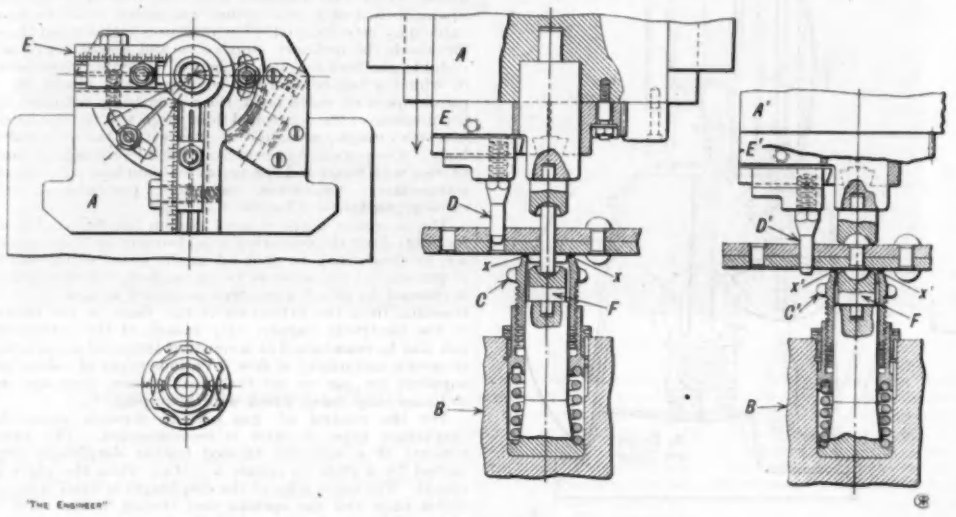


Fig. 1—Details of Pin Riveting Mechanism

Sectional views of the apparatus employed are given in Fig. 1. The equipment includes a rotary setting head E with centring pins D, and a device B for the exact distribution of the rivet blanks over the boiler walls. The rotary setting head is intended to hold the body to be riveted and simultaneously to centre the blank during the formation of the heads, so that both heads will be concentric. The two parts work together as follows:—On the movable pressure slide A of the riveting machine the setting head and centring pin are fixed as shown, and on the fixed holding-up head B of the riveting machine there is arranged the appliance for distributing the blanks. This appliance has an adjustable screw sleeve C. After inserting the rivet blank these devices take up the relative positions shown in the left-hand sectional view, the centring pin of the setting head projecting into one of the empty rivet holes. In this way the boiler shell is held firmly against lateral movement. Under the action of hydraulic pressure exerted by the riveting machine, the pressure slide, together with the setting head and centring pin, is moved forward in the direction of the arrow until both fingers x of the adjustable screw sleeve come level with the edge of the snap head F, the spring of the screw sleeve being compressed. During the upsetting process on the rivet head, the centring pin is pressed fully into the adjacent rivet holes, thus giving concentricity of the heads. The screw sleeve remains in its compressed position until the hydraulic pressure on the snap head is released, whereupon the sleeve returns to its normal position by means of the relieved spring. By this means the two heads are formed simultaneously and uniformly, the countersinks on both sides are filled, and the heads are closed, metal to metal.

Fig. 2 is a sulphur impression of a pin rivet joint made by this system showing the liquation zones. It will be observed that the rivet pressure is concentric with the axis, and that the heads are symmetrical. The appliances are fully patented in America, on the Continent and Great Britain.

We have had an opportunity of inspecting this apparatus in operation at Messrs. Adamsons' works, and were impressed by its simplicity, the cleanness of the metallic contact, and the uniformity of the work. Sections of riveted plates confirmed the claims made for the process by the inventors.

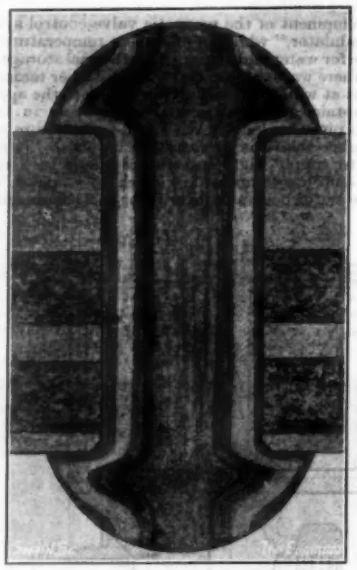


Fig. 2—Sulphur Impression of Pin Rivet Joint

Trial Results of the "White" Combined Steam Engine.

When describing in our last issue the "White" patented combined marine reciprocating engine and exhaust steam turbine, we referred to the official trials of the unit which had been made under the supervision of Engineer Commander C. G. Hawkes, M.Sc., R.N. (Ret.), Professor of Engineering at Armstrong College, Newcastle-upon-Tyne.

We have now received from Mr. W. A. White, of White's Marine Engineering Company, Ltd., of Hebburn-on-Tyne, particulars of Professor Hawkes' report, along with details of the full power trial. The engine, it will be recalled, operates on the triple-expansion principle, and has 10in., 14in., and 18in. diameter cylinders, with a stroke of 13in., at 276 r.p.m., superheated steam being supplied at about 220 lb. pressure. The indicator cards—which we do not reproduce—show, taking the area of the piston-rod into account, mean pressures of 69 lb., 38 lb., and 21·1 lb. per square inch for the high-pressure, intermediate pressure, and low-pressure cylinders respectively, with corresponding outputs of 94, 104, and 107 I.H.P., giving a total output of 305 I.H.P. for the engine alone without the exhaust steam turbine.

The average trial results are given in the following table:—

Average of Trial Data.

	Pressure, lb. per sq. inch.	Temperature, deg. Fah.
H.P. receiver	222	586
I.P. receiver	99	438
L.P. receiver	34	287
Reciprocating engine exhaust to turbine	0	210
Condenser	0·92in. abs.	—
Revolutions of reciprocating engines		276·3
Revolutions of turbine		4920
Revolutions of main shaft		119·6
B.H.P.		475
Steam consumption: 4482 lb. per hour		
9·44 lb. per B.H.P. per hour		
Mechanical efficiency of reciprocating engine and gears		0·846
Cylinder clearance volumes (mean):		
H.P., per cent.		21·62
I.P., per cent.		14·36
L.P., per cent.		12·11

It may be noted that the powers of the three cylinders are not quite uniform, but it is explained that this lack of uniformity was caused by a leakage of steam past the high-pressure piston valve, the engine having been previously balanced at the same cut-offs. Before the trial run, the engine had, we are informed, only been run off and on for less than 20 hours, and there had been no time available for running in the engine. It should also be borne in mind that the engine tested is a comparatively small one, with large volumetric cylinder clearances, and hence it cannot be expected to be so economical as a larger-sized engine would be, with smaller volumetric clearances. The figures which have been obtained are, it will be agreed, all the more interesting when it is remembered that the engine tested was of the usual marine construction and was built in an ordinary marine engine builder's shop, no extraordinary provision being taken regarding clearances or the grinding of piston valve chambers, piston liners, etc., all of which were plain bored. Notwithstanding these facts, when the steam consumption figures are compared with those of a good average normal triple-expansion marine engine, having a steam consumption of round about 13·7 lb. per I.H.P.-hour, or 15 lb. per B.H.P.-hour, the saving shown by the "White" combined marine engine is approximately 38 per cent.

Plate Type Air Heaters.

The accompanying engraving shows a plate type air heater, assembled at the works of the makers, Babcock and Wilcox, Ltd. It is one of four which is being supplied to the Dunston power station, at Newcastle-upon-Tyne, to be installed in conjunction with the same firm's two-stage boilers. In passing, it may be of interest to note that the heating surface of each boiler is 4417 square feet, from which a normal evaporation of 100,000 lb. per hour and a maximum evaporation of 125,000 lb. per hour of steam will be obtained. Firing will be with pulverised fuel. The air heater is of the cross-flow plate type, and consists of one or more single elements of plates, the alternate edges of which are so bent and welded together as to form a vertical gas passage and horizontal air passages. These heating plates are contained between two strong side plates. A series of gas-tight ducts is assured by curving over the edges of the heating plates after the corners have been cut out and welded together. The plates are separated by means of sleeves and sinuous strips, which also serve to ensure uniform distribution of air and gas across the passage. Long bolts hold the whole element together. As the heater is made of sections, any combination can be set up together to fulfil requirements as to capacity, and, if corroded, any element can be withdrawn and replaced with a minimum of trouble.

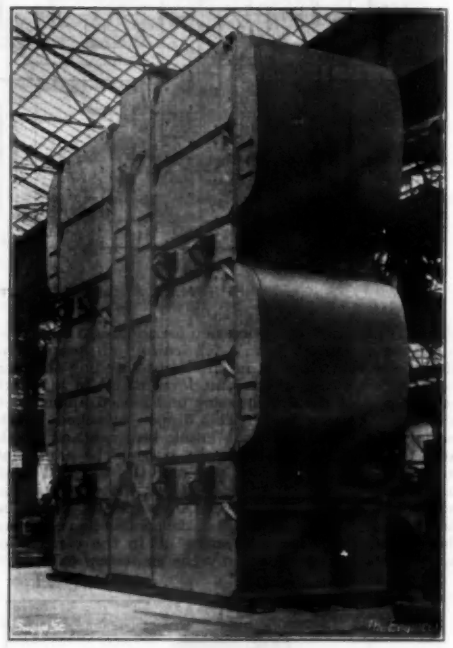


Plate Type Air Heater

The actual weight of permanent material in the Hunta-Sudbury 132,000-volt transmission line in Canada, which is 192 miles long, is 12,700,000 lb., of which tower steel comprises 8,600,000 lb., insulators and fastenings 620,000 lb. and cable 3,480,000 lb. Telephone cable and poles, tools, food, equipment, &c., required in its construction added another 1,800,000 lb., so that the whole amount of material handled from railhead amounted to about 14,500,000 lb. When it is realised that the total movement was equivalent to moving approximately 112,000 tons a distance of 1 mile, some idea of the magnitude of the task may be obtained.

A recent official investigation by the Board of Trade nto the circumstances of the "explosion" of a boiler in a foreign-owned ship, which resulted in one fatality and two other casualties, has induced the Engineer Surveyor-in-Chief to make the following remarks:—The caulking of tube plates around leaky stay tubes is frequently thought to make an effective repair, but the actual effect is to close in the finely screwed ends of the tubes, and thereby force the threads of the tubes away from those in the tube plate, further reducing their holding power already adversely affected by corrosion. The danger arising from this practice is clearly illustrated in this case, and cannot be too strongly emphasised. Leaky stay tubes should be dealt with by expanding them into the screwed holes in the tube plate and not by caulking the tube plate to the tubes; if this does not prove to be effective, they should be replaced by stay tubes screwed to fit tightly into the tube plates.

Railway "Efficiency."

IN the current issue of the *Great Western Railway Magazine* Mr. H. E. Hedges, F.S.S., gives an efficiency index table for the G.W.R. This index is designed to show, by means of a simple combination of the principal operating factors, an "index" which is broadly representative of the Great Western Railway Company's general operating performance. Ten representative statistical units relating to the operation of passenger and freight trains have been therefore selected, and a datum line formed in respect of each by regarding the average of the three years 1923–25 as representing 100. These years were selected as they furnish the longest available consecutive period of normality, so far as trade conditions are concerned; they are also particularly appropriate as being the first years of amalgamation under the Railways Act, 1921. Upon this basis the table was built up, and it shows the relative position of the various units in each succeeding year, as a percentage variation. It is obvious that the final "index" figure produced by this method is not scientifically accurate; such a statistic would only be attainable if each of the various factors were of equal value, or could be made so by a system of weighting; this would be virtually impossible. The combined "index" figure is, however, sufficiently representative to make it of much interest. When, however, each of the statistical averages which have been used to make up the index is taken separately, a strictly accurate comparison is available, and the detailed analysis has therefore been included in the table. The italicised figures are the actual statistical averages in respect of each item, and the Roman figures represent the relative percentage variations compared with the basis period. A brief examination of the different items will show the relative progress or retrogression in passenger and freight train operating efficiency compared with the period immediately following the formation of the Great Western group. It is not difficult to visualise the close relationship between the results achieved and important items in the company's annual expenditure on railway working, which during the year 1931 amounted to close upon 22 million pounds. The fall in the records in certain cases is attributed to decrease of traffic.

Unit.	Three years' average, 1923–4–5.	1926.	1927.	1928.	1929.	1930.	1931.
(1) Average wagon load, tons	*5·83*	*5·11*	*5·78*	*5·75*	*5·90*	*5·77*	*5·62*
	100·0	87·65	99·14	98·63	101·20	98·97	96·40
(2) Average train load, tons	*135·28*	*126·13*	*135·6*	*133·04*	*138·47*	*134·33*	*129·48*
	100·0	93·24	100·24	98·34	102·36	99·30	95·71
(3) Wagon miles per engine-hour	*108·27*	*112·14*	*109·72*	*112·88*	*112·80*	*114·27*	*115·26*
	100·0	103·57	101·34	104·26	104·18	105·54	106·46
(4) Train miles per train hour, freight	*8·20*	*8·45*	*8·24*	*8·83*	*8·64*	*9·05*	*9·34*
	100·0	103·05	100·49	107·68	105·37	110·37	113·90
(5) Net ton-miles per engine-hour	*417·29*	*397·38*	*419·73*	*430·94*	*440·49*	*438·79*	*431·33*
	100·0	95·23	100·58	103·27	105·56	105·15	103·36
(6) Train miles per train-hour, coaching	*13·53*	*13·32*	*13·41*	*13·35*	*13·34*	*13·43*	*13·42*
	100·0	98·45	99·11	98·67	98·60	99·26	99·19
(7) Locomotive stock, percentage of number available to stock	*74·76*	*75·49*	*74·68*	*75·05*	*77·33*	*78·46*	*78·59*
	100·0	100·98	99·89	100·39	103·44	104·94	105·12
(8) Engine miles per day per engine in use	*103·06*	*102·63*	*102·68*	*103·73*	*103·90*	*103·35*	*102·75*
	100·0	99·58	99·63	100·65	100·82	100·28	99·70
(9) Coal consumption, coaching (lb. per mile*)	*0·0248*	*0·0229*	*0·0244*	*0·0246*	*0·0244*	*0·0244*	*0·0240*
	100·0	92·34	98·39	99·19	98·39	98·39	96·77
(10) Coal consumption, freight (lb. per mile*)	*0·0178*	*0·0175*	*0·0176*	*0·0183*	*0·0183*	*0·0185*	*0·0185*
	100·0	98·31	98·88	102·81	102·81	103·93	103·93
Total	100·0	97·24	99·7	101·39	102·27	102·61	102·05

* Converted into "miles per lb." to secure relative percentage variation.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

August Holidays.

THE past week has been uneventful, alike in industrial and iron and steel producing and selling circles in the Midlands and Staffordshire, August holidays accounting for lack of activity at the works and in the market. At a great number of establishments normally engaged upon heavy engineering production, a full week's idleness was dictated by the small volume of work on the books. In one or two exceptional cases, ten and even fourteen days of holiday were decided upon. In some of the lighter industries of the area, the trade position is better, and works resumed at mid-week. The blast-furnaces continued in operation, it being uneconomical to cease operation. As works are not consuming the metal however, output has gone to swell the already large stocks. The majority of works hereabouts have sufficient raw material on the ground to enable plant to make a restart. Consequently there was practically no business transacted on the iron and steel market in Birmingham this week. There was a very poor attendance at the weekly meeting, most firms' representatives being on holidays. Stocktaking has been in progress at a number of the works, this being considered a most convenient time for this to take place. It is trusted that next week will see some development in trade, and although definite signs of revival are wanting, optimism is maintained.

Extracting Oil from Coal.

Investigation at the Birmingham Research Laboratory into the conversion of coal into oil has been suspended. The annual report of the Executive Board of Mining Research on the work of the Mining Research Laboratory at Birmingham University states that hydrogenation investigations in the laboratory have been discontinued because the minimum cost of large-scale production cannot be brought sufficiently low to compete with the present exceedingly low price of imported petrol and oil fuel. It has been decided that further expenditure upon hydrogenation researches is inadvisable, but that investigations of the utilisation of coal in other directions would seem to be more profitable from the point of view of the coal industry. For the time being the programme at the Mining Research Laboratory has been rearranged to include certain aspects of the application of gas under high pressure as a substitute for petrol for municipal transport services.

Edge Tools.

The heavy edge tool trade in the Midland area is disposed to fall away again after a slight improvement, and some Staffordshire firms which have been busy for the past month or so closed down for ten days for the holidays. Inquiries are reported to be fairly numerous, although orders are invariably for small tonnages. Producers complain of unremunerative business, especially on export account. The South American market is showing signs of revival and hopes are entertained of substantial orders from that quarter in the near future. Egypt and China have recently ordered tools required for development work. Firms supplying the home trade have had a fair season, having regard to the general state of affairs.

Order for Steelwork.

It is announced that the Patent Shaft and Axletree Company, Ltd., of Wednesbury, has just received from the Union of South Africa Railways and Harbours Administration a contract for the supply of the steelwork for four 150ft. skew through spans and abutments required for the new Umlaff River bridge, Natal.

Pig Iron Prices.

Dspite the fact that the question of pig iron prices has been widely discussed of late, the Central Pig Iron Producers' Association at its usual monthly meeting decided to make no change in the selling price of iron for the current month. Outside opinion is that smelters are waiting for the autumn reinvigoration of demand before deciding upon any alteration in selling rates. This month is bound to be a quiet one, as far as business is concerned, although a gradual expansion of demand from the light foundries is anticipated. Works which produce castings for the domestic heating trade should enter upon their usual active season as soon as the holidays are out of the way, and they will require more material than they have been consuming of late. Midland blast-furnaces are overstocked at date, and demand will have to increase very substantially before additional plant will become necessary to satisfy consumers' requirements. Minimum selling rates of Midland brands of pig iron for the month are as follows:—Northamptonshire: Forge, £2 17s. 6d.; No. 1 foundry, £3 5s. 6d.; No. 2, £3 4s. 6d.; No. 3, £3 2s. 6d.; No. 4, £3 1s. 6d. Derbyshire: Forge, £3 1s.; No. 1 foundry, £3 9s.; No. 2, £3 8s.; No. 3, £3 6s.; No. 4, £3 5s.—all per ton delivered to stations in the Black Country and subject to rebate in the case of large buyers.

Steel.

The position in regard to heavy structural steel shows a little improvement, the holiday break bringing some relief to steelmasters who have been struggling to obtain sufficient specifications to keep the mills rolling from day to day. There has been some accumulation of orders. Unfortunately at the moment the prospects of general engineering firms buying and using steel in larger quantities are not bright. Buying is confined to immediate requirements, consumers being in no way anxious to guard against emergencies by purchasing forward. Quotations for finished steel are upheld at the level fixed by the Steelmasters' Association, namely, angles, £8 7s. 6d.; tees, £9 7s. 6d.; joists, £8 15s.; and ship, bridge, and tank plates, £8 17s. 6d. All these prices are subject to rebates in the case of buyers confining themselves to the use of British steel. Conditions in the half-products department show no change. Demand is small and values are unaltered. Staffordshire re-rollers quote small steel bars re-rolled from Continental material £6 7s. 6d. upwards, and all-British bars £7 upwards. Mild steel billets range in price from £4 17s. 6d. to £5 7s. 6d.; while sheet bars are £4 15s. upwards. Prices quoted by Continental houses are unchanged on the week.

Finished Iron.

Holidays have been general throughout the week in the Staffordshire finished ironworks. For some time past the mills have been very short of work, and part-time working has been the rule. There is a small carry-over at the marked bar mills, but in the other branches the restart depends upon what work comes along this week. Selling rates are as a week ago in all departments. Marked bars command £12 per ton at makers' works; Crown bars range in price from £9 to £9 15s.; nut and bolt bars are round about £8; fencing bars, £7 15s.; and wrought iron tube strip, £10 10s. delivered.

Galvanised Sheets.

Although quotations for 24 gauge galvanised corrugated sheets are maintained at £9 5s. per ton, f.o.b. Liverpool, orders are reported to have been accepted this week at half a crown below this figure. There is but a small volume of business about, although orders are numerous. Competition is exceedingly keen, and inquiries are closely followed up.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

A Fall in Unemployment.

FOLLOWING upon an increase in unemployment in Lancashire in the previous month, the returns covering June show a slight improvement, the reduction in unemployed workers amounting to 1·2 per cent. The percentage of unemployed varies, however, from as low as 7·3 at Irlam, 8·7 at Leyland, and 11·5 at Prescot to as high as 55·4 at Hindley, near Wigan, which is essentially a coal-mining area. Depression in the cotton towns is a factor which materially helps to swell the unemployment returns, but a relatively bigger adverse influence is the state of the coal-mining industry, the average of unemployment in the Lancashire and Cheshire coalfield as a whole reaching just over 44 per cent., which is appreciably higher than the national average for the coal-mining industry. Manchester at 15·1 per cent. is not badly situated, but the neighbouring city of Salford provides a return just short of 25 per cent., whilst the depression in the shipping and shipbuilding industries is amply reflected in the figures of 27·6 per cent. for Liverpool and 35·6 per cent. for Birkenhead.

Reduction of Capital.

In the Lancashire Chancery Court at Liverpool, the Vice-Chancellor, Sir Courthope Wilson, K.C., sanctioned an application by the Blackburn Loom and Weaving Machinery Making Company, Ltd., of the Phœnix Ironworks, Blackburn, for the reduction of the capital of the company from £110,000 to £54,000 by the return and cancellation of preference capital and the reduction by 60 per cent. of the ordinary capital by the return of £6 per £10 share. In support of the application, it was stated that the present capital was not required for the amount of trade that was now being done. The company, said counsel, had been successfully managed and had surplus assets amounting to £143,547.

Manchester University Appointments.

Manchester University appointments in the Faculty of Technology which have been approved by the Council include the following:—Dr. H. P. Walmsley, Lecturer in Physics; Mr. W. A. S. Cormack, Assistant Lecturer in Building Construction; and Mr. J. H. Hawkes and Mr. Arthur Howarth, Assistant Lecturers in Mathematics.

Industrial Results.

The directors of the Lancashire Electric Light and Power Company, Ltd., have declared an interim dividend on the ordinary share capital of 2½ per cent. The trading profit of Thomas Bolton and Sons, Ltd., copper smelters, of Widnes, for the twelve months to the end of March amounted to £31,944, but after meeting debenture interest and other charges, revaluing stocks, &c., there is a debit balance of £25,032 to be carried forward, which compares with a credit balance of £82 a year ago.

Iron and Steel.

The Bank Holiday has had an unmistakably quietening influence on the iron and steel markets this week. Deliveries of foundry iron into consumption in the Lancashire district are only on a moderate scale, and at the moment little in the way of new contract buying is going on. The price position, however, keeps steady all round, offers of Derbyshire, Staffordshire, and North-East Coast brands of No. 3 for delivery to users in the Manchester district all being at 67s. per ton, with Northants at 65s. 6d., Derbyshire forge iron at 62s., Scottish foundry at up to 85s., and West Coast hematite at 81s. Inquiry for bar iron is on a strictly hand-to-mouth basis, but at £9 15s. per ton for Lancashire Crown bars and £10 5s. for best quality material, prices in this section of the market are also well held. Forward buying in the case of steel, more especially of the heavy products, has been negligible this week, and the bulk of the limited business that has been reported on this market has consisted of specifications for odd parcels, which altogether have involved only a small tonnage. No branch of the heavy steel-using industries in Lancashire is busy, but the position appears to be relatively worse in respect of constructional engineering firms, only one or two of whom have reasonable order books. Meanwhile, small bars are offered by re-rollers at from £6 15s. to £7 per ton, according to quantity, and boiler plates at from £8 10s. to £8 12s. 6d. The controlled products are maintained on the basis of £9 7s. 6d. per ton for large-diameter bars, £8 7s. 6d. for sections, £8 15s. for joists, and £8 17s. 6d. for general plates.

Non-ferrous Metals.

Allowing for the effect of the Bank Holiday, there has been more liveliness in evidence in almost all

sections of the non-ferrous metals market during the past week, and rather sharp advances have been recorded generally. The dominating influence has no doubt been the more cheerful tone in the United States. This has imparted a firmer feeling, and at the low rates lately ruling buying interest on a bigger scale has been induced. Whilst much of this activity has been speculative in character, there has also been slightly more confidence displayed by trade consumers in this country, as well as on the Continent and in America. The continued gradual improvement in the statistical position of tin has, in itself, been a "bullish" factor in this section of the market, and there has been an advance on the week of rather more than £8 per ton, bringing the prices current at the moment of writing to about the best seen since early in March. A rise on balance of about £2 10s. per ton in standard brands of copper has been in no small measure in sympathy with tin, although, here also, trade inquiry has been a shade better. More active conditions have been reported in both the lead and spelter sections, and in each case current quotations are roughly 15s. per ton higher than they were a week ago.

BARROW-IN-FURNESS.

Hematite.

With the coming of the holidays there has developed a quietness in trade, and the general state of the pig iron market is dull. This condition is likely to continue for some weeks. It is not expected that the home trade will show much forward movement immediately, but there is a certain amount of optimism about the future. Prices are low, yet orders for forward delivery are not in evidence. Up to the present, overseas buyers are not ordering, but some hope is based on the trend of negotiations with Canada. Continental business is very low, and likely to be so for some time, and the same remark applies to America. The iron ore trade is very quiet, owing to present restrictions of output, both locally and at other ironworks. Foreign ore is in easy demand. The steel market continues dull, with very little promise for the immediate future. Shipping is quiet.

SHEFFIELD.

(From our own Correspondent.)

An Extended Holiday.

THIS week has been more broken than August Bank Holiday week usually is in Sheffield, as the suspension of work has been on an extended scale. Most of the large firms closed for the full week, and, although in many cases the period was shorter, the resumption in some instances was not complete, a great deal depending upon the inflow of orders. All branches of the United Steel Companies' works, including the steel melting furnaces, were closed, but there was no special significance in this fact, as it is the usual practice. The general condition of trade before the holiday showed no improvement; rather had the prevailing dullness been increased by the falling off of transactions in preparation for the stoppage. The production of steel had been continued on about the same scale as recently, the furnaces being only very moderately employed. The demand for stainless steel, motor car parts, steel strip, and best quality wires keeps up well.

The Outlook.

It cannot be said that immediate prospects for Sheffield trade are encouraging, as inquiries in many departments are poor, and the Irish difficulty is liable to deprive this country of export trade at a time when that side of our activities is already very quiet. There is, however, still confidence in an improvement in the late autumn. Optimists base their arguments on the fact that we live in a steel age, and that the depletion of stocks of goods and material all over the world cannot go on indefinitely. Such stocks are becoming exhausted by the policy of severe economy that has been carried on for a long period, and it is felt that there must be a limit to this policy, and that when it is reached a rapid expansion of trade from every source will be highly probable. Some markets have already been compelled to modify their policy of reducing imports. In the meantime, however, the conditions in Sheffield remain very unsatisfactory. They are making continued economies necessary, and reductions of staff are still being carried out at some establishments.

Orders from Abroad.

The call for shipbuilding steel continues very poor, and nothing much better can be said of the trade in railway material. The shops making axles, tires, and springs could do with a lot more work. An interesting order placed during the week is one received by John Baker and Bessemer, Ltd., of Rotherham, for wheels and axles for the Danish State Railways. They are for use on the new motor coaches in connection with the electrification of the railways, for which British contractors recently secured an order for electric train equipment to cost £300,000. It is pleasing to note that the Danish market for British steel products is increasing. "Quality," the organ of the Sheffield Chamber of Commerce, reports that good orders have been obtained for dredger buckets for foreign engineering purposes, and that increasing quantities of stainless steel are being sent to Switzerland for the manufacture of clock faces and hands for watches.

Trade with the Irish Free State.

The Irish Free State tariff is a matter of special interest just now, and it is not quite clear whether the 20 per cent. applies to cutlery and tools. Although these products are not included in the published list, the Free State Finance Bill states that the duty is also to apply to "articles which, in the opinion of the revenue authorities, are made wholly or mainly of iron and steel and either of them." The Free State has for several years been a good market, with several Sheffield firms, for cutlery, tools, and electro-plate. Only a few months ago, one firm in the city executed the largest order ever received from that country for table ware, for the refreshment caterers for the Eucharistic Congress in Dublin. The iron and steel exported to the Free State consists chiefly of galvanised sheets and iron bars. Large quantities of steel parts for tractors were bought from Sheffield by the Ford Company at Cork before the trade slump.

Russian Business.

Sheffield's trade with Russia, which was formerly on a very extensive scale, has shrunk greatly since the war, and at present it is exceptionally quiet, owing to financial difficulties. It is stated that a sum of £1,600,000 for Russian credits, which the British Government Export Credits Department provided a few months ago, is now exhausted, and at present nothing more is available. The consequence is that business for machine tools, general tools, and agricultural machinery, which Russia is willing to place with Sheffield, cannot be allocated. There are at least six large Sheffield firms waiting to take orders that Russia wishes to place, but it does not appear likely that any business will be done until the Government credits are renewed. German manufacturers are capturing a large amount of trade, as they have come to an arrangement whereby they will give the credits that the Russians want.

Marking Foreign Tableware.

Sheffield is pleased that the Standing Committee set up under the Merchandise Marks Act, 1926, has recommended that an indication of their origin shall be placed on spoons and forks (other than carving forks) made wholly or partly of metal. The Master Silversmiths' Association of the city took a leading part in the application for a marking order. Mr. R. H. C. Ward, secretary of the Sheffield and North-Eastern Area of the National Union of Manufacturers, states that Sheffield manufacturers are now making tableware almost as cheaply as it can be done abroad, and the new regulation will mean that they will get the orders. Large quantities of foreign spoons and forks have been used in certain restaurants, but the proprietors will probably be averse from using them when they bear marks showing their foreign origin. He calls attention to the use on foreign cutlery of such words as "stainless," "stainless plate," and "whitethro," with nothing to show that the articles are of foreign origin, and points out that the use of such terms leads the ordinary purchaser to believe that the articles are of English manufacture. The Committee's recommendation also applies to knives, the blades of which are made wholly or partly of metal other than steel or iron.

Flood Problems.

The question of flood prevention has assumed more urgent importance since the damage caused by the recent rises of the rivers, and the problem of Bentley, the colliery village in the Doncaster district, is outstanding. At a meeting of the Ouse Catchment Board last week, Major F. H. Fawkes, High Sheriff of Yorkshire, said that when Bentley Pit was sunk, in 1909, there was a subsidence over 2000 or 3000 acres, and the water, instead of flowing by gravitation to Thorpe Marsh, passed into the big saucer caused by the subsidence. He said that 3104 houses had been built in the Bentley area since coal-mining commenced, and added that more houses were now being built on sites which were flooded last May. There had been subsidences of over 4ft. in some parts, and he was told that builders had even had to stop building temporarily because flood water was running through their foundations. Alderman Beardsley, an ex-Lord Mayor of Sheffield, said that an engineer had estimated that the subsidence in the next 50 to 100 years would be about 10ft. There is to be a conference between representatives of the Catchment Board and the Doncaster District Drainage Board. In Derbyshire, the County Council has decided on an expenditure of £8026 to make good damage done to roads and bridges by the May floods.

Smoke Abatement.

Sheffield has made some progress in combating the smoke nuisance, but a good deal remains to be done. Mr. James Law, the chief smoke inspector for the Sheffield, Rotherham, and District Smoke Abatement Committee, reports that research work is being carried out at Sheffield University and at a number of steel works in order to determine the best practical methods of obviating the smoke nuisance caused by furnace chimneys without detriment to the material being manufactured. There are a considerable number of furnaces working in the area which are so badly constructed that they offend every law of combustion, and in their present state will never be anything better than smoke-makers. The reconstruction of these furnaces is going to be a formidable task that cannot be carried out quickly; it will be a matter of gradual transition from the old type of furnace to the new. He adds that it can be stated with certainty that the area is now in the first stage of reconstruction work, and credit must be given to the manufacturers who have done pioneer work in that direction, and have found some definite solution to the difficulty.

Railway Wagon Works.

It is intended temporarily to close down the shops at the York carriage and wagons works of the L.N.E.R., when orders at present on hand are completed. This step is due to lack of new work, consequent on the depression in passenger traffic. It is not proposed to close the works permanently, but to dispense with the services of most of the staff until there is a revival. At present, wagon repairing is almost at a standstill, as the company has more wagons than are needed to cope with the demands made by the smaller volume of goods traffic.

NORTH OF ENGLAND.

(From our own Correspondent.)

Big Order for Tyneside.

ANOTHER valuable order for electrical plant has come to Tyneside. C. A. Parsons and Co., Ltd., of Heaton, have secured a contract for the supply of a 30,000-kilowatt turbo-alternator and condensing plant for the Southwick power station, Brighton. The contract is subject to an agreement with the Central Electricity Board. The plant will consist of a tandem cylinder turbine designed for a steam pressure of 650 lb. per square inch and a temperature of 850 deg. Fah. It will be provided with feed heating in four stages, and will be coupled to an alternator generating at 8000 volts and running at 3000 r.p.m. The value of the contract is in the neighbourhood of £50,000.

Iron and Steel Works Close Temporarily.

Taking advantage of the opportunity afforded by the slack holiday period of the year, the Skinningrove Iron and Steel Company is to close down its works for a fortnight, from August 6th to 20th, to enable the change of frequency in the electrical grid scheme to be made. At the end of that period it is intended to resume in full swing. About 1000 men will be affected by the temporary stoppage, and for a time East Cleveland will be without a single industry in operation. The four blast-furnaces will be damped down, and the remainder of the departments—the steel plant, rolling mills, and construction shops—will be closed down entirely. Some of the coke ovens will be kept in action. The Loftus ironstone mine, from which the Skinningrove works receives the bulk of its ore, will also be laid idle for a fortnight.

Cleveland Iron Trade.

The temporary stoppage of the four blast-furnaces at Skinningrove, following upon a stoppage *sine die* at the Normanby Ironworks, is not likely to cause any inconvenience. On the contrary, it will afford a welcome opportunity for the reduction of stocks of unsold iron at the makers' works. The number of blast-furnaces in operation on the North-East Coast will be reduced to fifteen, which is the smallest number which has operated since the coal strike. Hopes are entertained of an early revival, but the position at the moment is disappointing, and August cannot fail to be a month of dull trade. Very little iron is going to Scotland, and generally there are indications that holiday interruptions will be longer than usual. However, on the subject of prices, producers maintain a firm front. No. 1 Cleveland iron is 61s.; No. 3 G.M.B., 58s. 6d.; No. 4 foundry, 57s. 6d.; and No. 4 forge, 57s.

Hematite Pig Iron.

It is difficult to fix values of East Coast hematite pig iron, but ordinary qualities are no more than 61s., and 61s. 6d. is a full quotation for No. 1 grade. Makers are stated to have sold at less, and merchants do not hesitate to undersell producers.

Iron-making Materials.

There is no new feature in the foreign ore trade. Nominally, best Rubio ore is 14s. 9d. c.i.f. Tees. Blast-furnace coke is plentiful, and slow of sale. Good average qualities are offered at 15s. 3d. delivered to North-East Coast works.

Manufactured Iron and Steel.

In nearly all branches of the manufactured iron and steel trade scarcity of orders is acute, and fear is felt that more plant will have to go out of action. There is still a good deal of work to do in departments engaged on the manufacture of constructional steel, but in sections producing railway material order books are light, and makers of shipbuilding requisites have very little work on hand. Prices are unaltered.

Iron and Steel Exports.

The iron and steel exports from the Cleveland district for July fell short of the June tonnage by 7001 tons. Not for years has so little pig iron been shipped as in July, and less manufactured iron and steel has been shipped than in any month since February last. Total shipments of pig iron for the month amount to no more than 6388 tons, compared with 11,920 tons in June, and Scotland's share of the July clearances fell to 2101 tons, the lowest figure recorded this year. The decline in manufactured iron and steel shipments was less marked, the July tonnage being 29,603, compared with 30,506 tons in June. Actually, shipments to foreign destinations were on a better scale, but this improvement was offset by reduced deliveries to home ports.

The Coal Trade.

Business in the Northern coal trade this week has been under lifeless conditions. As August advances, it is believed that the demand will improve, but so far as foreign business is concerned, exporters contend that the minimum prices are the stumbling block. Recent contracts have shown the continued severity of Polish competition, and Germany is likely to secure a considerable share of the Irish Free State coal trade. It would seem that some form of elasticity in minimum prices is needed to combat particular phases of foreign competition. The Swedish naval authorities recently invited tenders for the supply of 9000 tons of coal, and it is understood that the contract has been secured by Poland at very low figures. The price is said to be about 14s. 3d. per ton c.i.f., which would leave about 10s. for the coal, or fully 2s. per ton less than Northumberland's lowest minimum price for large steams. With no special feature and a general lack of inquiry, prices are quoted unchanged. Northumberland best steams are 13s. 6d. and seconds 12s. to 12s. 6d. Gas coal moves slowly. Best qualities are in good supply at 14s. 6d., and special Wear at 15s. The bunker trade con-

tinues quiet. Inquiries are not in evidence, and sellers offer best qualities at 13s. 6d., and ordinary at 13s. Gas coke is holding fully steady under a moderate volume of inquiry. Stocks at this season of the year are not excessive, and show little increase on last month's quantities. Prices hold steady at 17s. to 17s. 3d. prompt and 17s. 6d. autumn. Patent oven coke rules quiet and unchanged in price at 14s. for good brands and 15s. to 16s. for superior makes.

Coal Trade Wages.

The accountancy ascertainment of proceeds and costs in the coal industry in Durham county for June shows similarity to that of May. The figures would, but for the minimum additional percentage to basis rates under the county agreement, determine miners' wages in August, though, as for many months past, there will be no change. Having regard to the apparent lower demand for coal in June, the results are as satisfactory as might have been expected. The percentage on basis wages would be 28·64, as compared with 29·50 in May, a decrease of 0·86 per cent. The minimum additional percentage is 65; therefore the deficiency to be made up by the owners in terms of the agreement is 36·36 per cent.

SCOTLAND.

(From our own Correspondent.)

Shipbuilding.

THE output from Clyde yards during the month of July totalled three vessels of 2500 tons aggregate, thus bringing the total output for this year to date up to nineteen vessels of 39,745 tons aggregate, compared with forty-two vessels of 120,412 tons aggregate in the same period last year. The low output this year is a fair reflection of the state of the industry, particularly in the upper reaches of the river, where ship repairing has been almost the only source of employment. Consequently it is somewhat gratifying to find that the month of July has been the most encouraging period this year so far as inquiries for new tonnage are concerned. The inquiries referred to include private and Admiralty work. In respect to new work, July was also the most satisfactory month this year to date. Lithgows, Ltd., Port-Glasgow, received another order from J. and C. Harrison, London, for a cargo steamer of about 9000 tons deadweight, and similar in design to the other Harrison boats at present under construction by the same firm. Since August, 1931, Lithgows have received from J. and C. Harrison orders for about 54,000 tons deadweight of shipping. The Blythswood Shipbuilding Company, Ltd., Scotstoun, Glasgow, secured an order for a tanker of about 200ft. in length from London owners, and Ferguson Bros., Port-Glasgow, obtained a contract for a sludge steamer of 243ft. by 38ft. by 16¼ft. from Manchester Corporation.

Free State Tariffs.

The effect of the Free State tariffs against British goods becomes more clearly defined. The Ayrshire and Lanarkshire coalfields, more especially the former, will be considerably affected. There is, of course, the possibility that Continental fuel may not be suitable to consumers' requirements. On the other hand, in some quarters here the opinion is strongly expressed that the tariff will be increased sufficiently to exclude British coal from the Irish Free State. The steel trade also will be affected, having now to face a tariff of 30 per cent., compared with an impost of 15 per cent. on Continental material.

Steel and Iron.

The steel and ironworks have just made a restart, the annual holidays having lasted sixteen instead of the usual ten days. Reports indicate that the amount of business which accumulated during the stoppage has been comparatively small and that immediate prospects are not particularly bright. At the same time, confidence is being upheld by hopes of trade arrangements as an outcome of the Ottawa deliberations. Already it has been noted that Canadian buyers have been more favourably inclined towards British materials, and although the interest has perhaps only found material expansion in an increased trade in sheets, producers here anticipate participation in other lines possibly in the near future. Sheets are one of the few descriptions of iron or steel material to show any increase in export over last year, but the position will probably become more difficult in view of the decreasing demand from the Far East unless business with the Dominions can be increased sufficiently to offset the loss elsewhere. In the meantime heavy steel tubes, bar iron, re-rolled steel bars, and pig iron move very slowly and prices are unchanged. Scrap likewise is quiet, with prices easy at about 45s. per ton for cast iron machinery and 35s. per ton heavy steel.

Coal.

The feature of the coal market is the strength of washed treble and double nuts, especially the former, owing in a measure to the decrease in the production of large coal. West of Scotland round fuels have a poor market and will be affected by the Free State tariffs, and the collieries in the Lothians and Fifeshire still experience considerable difficulty in securing export orders for prompt delivery, the bulk of the business being in a coastwise direction. Forward transactions are practically impossible. Aggregate shipments during the past week amounted to 232,123 tons, against 114,503 in the preceding week and 155,760 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

The Coal Trade.

FROM the point of view of actual business, the conditions during the past week or so have been extremely quiet, as was to be expected in view of the holidays. Last week finished up badly, as the total of vacant loading berths reached the figure of fifty-three, and of this number, five were at Swansea, where the principal loading pressure has been experienced of late. As previously mentioned, it was agreed that work after the holidays should be resumed on the loading of steamers at Swansea on Tuesday, and at the other ports on Wednesday, but it was rather unfortunate that after going to the trouble of making this arrangement for the special benefit of Swansea there should be a perceptible slackening of operations. On Tuesday the returns showed that the loading pressure was much less than had been anticipated, as there were five vacant loading berths. Shipments from the whole of the ports under the control of the G.W.R. Company were, in fact, rather disappointing last week, as the total only came to 394,745 tons, compared with 394,275 tons for the preceding week, and with 448,041 tons for the corresponding period of last year. The returns for this week will, of course, display a marked reduction, in view of the holidays at the mines and the docks. Actual business has been on a negligible scale. In the case of steam coals, most grades are so freely available for prompt loading that there is no encouragement to buyers to operate ahead, and new orders are so restricted in number that they make no impression on the market or the stocks of coal standing. Apart from an inquiry for 10,000 to 12,000 tons of Welsh coal for the Mauritius Railways, there was no feature in the business from abroad, while nearer home the Swansea Corporation electricity department is in the market for supplies of small nut and through coals for delivery over six or twelve months from November next. News from other directions is not without interest, as, for instance, the report that there is a possibility of a consortium being formed in Italy for the distribution of all coal imported into that country. This possibly may be a counterblast to the report of centralised coal selling in this country, as the formation of a consortium for the distribution of coal in Italy would mean the centralised buying of coal. As regards business between South Wales and the Irish Free State, there has been no outstanding development. It may be mentioned that coal cargoes arriving at Irish ports up to the night of the 27th ult. were duty free, but it is interesting to note that several small cargoes from this district were due to arrive at their Irish destinations since that date, and tonnage is still being chartered, which shows that a certain amount of business is still being arranged. Some shipments are being effected in the case of f.o.b. contracts with Irish Railways, but as to how these contracts actually stand, no definite news is at the moment forthcoming. Presumably the railways have to pay the tax, and in the case of small cargoes of coals of about 200 to 400 tons, the Irish receivers have to pay the duty. As was pointed out recently, quite a number of small Irish buyers can only take cargoes for the small ports of about 200 to 400 tons, and it is difficult for them to get their requirements anywhere else than from this country, for the reason that such small vessels have not the bunker capacity to trade from Rotterdam or Emden. In the event of an embargo being placed on British coals, it would mean that many of these small Irish buyers would have to import on a collective basis, but it is questionable whether with the increased costs of distribution which would be entailed, they would be any better off. So far as can be ascertained, a fair amount of business has already been done in German coals for such ports as Dublin and Cork, and, of course, the c.i.f. prices for German coals for cargoes of 800 to about 1500 tons are lower than the cost of Welsh coals, to which, so far as the receiver is concerned, has to be added the tax of 5s. per ton. The difference in favour of the German coal may be anything from 2s. 6d. to 3s. 6d. per ton, which is a considerable item to the buyer.

Newport's New Waterworks.

On Thursday of last week the Mayor of Newport, Councillor G. J. Jones, cut the first sod for the reservoir dam for Newport's new waterworks undertaking at Talybont, while Alderman T. Parry, the veteran Chairman of the Waterworks Committee, opened the new by-pass road to the waterworks, the latter having worked unceasingly for about sixteen years to bring this scheme about. The cost of the work inaugurated on Thursday last week will be £368,000, but the scheme in its entirety will run to £430,000. The site for the dam is about 1500 yards north of the original site, which was found unsuitable, and resulted in many trial borings having to be taken before engineers and geologists were prepared to recommend it. The reservoir is 36 miles from Newport in the Glyn Collwyn Valley, and the water to be impounded is the water of the river Caerfanell, which flows over the Brecon Beacons and enters the Usk at Talybont. The total capacity of the reservoir will be 10 million gallons. Its length will be nearly 2 miles, and its greatest width 500 yards. The length of the dam will be 460 yards. The reservoir will contain 2500 million gallons of water, and taking the average consumption of water at 25 gallons per head per day, the reservoir will supply the needs of 400,000 people. With its other reservoirs, Newport will therefore have an adequate supply of water to serve a population of over half a million. Its present population is about 100,000. The work is being carried out with the aid of a Government grant, and it is a condition that in the carrying out of the contract 90 per cent. of the workmen must be taken from the Newport labour exchange. An average of 300 men will be employed for three years. The contractor is Mr. J. McColville, of Abergavenny, and the engineer for the scheme is Major W. E. Lloyd, M.C., the Newport Borough Engineer; the consulting engineer is Mr. Macaulay, of Birmingham; and the geologist, Dr. Lapworth.

Steel and Tin-plate Items.

This is stop-week in the tin-plate industry of this district, and the same applies to the steel workers at the South Wales Steel Works, Llanelly, where recently there has been a dispute which threatened to be of a rather serious nature. Notices which have been served on the employees to take effect on Saturday last have, however, been withdrawn, and the furnaces will be relit for a resumption on the 8th inst., but the restart on the bar mill will not take place until the 15th inst. The withdrawal of the notices to the workmen came about at the end of last week, when it was officially announced that the Iron and Steel Trades Confederation had been informed by Richard Thomas and Co., Ltd., that they had agreed to the procedure of allowing matters in dispute at their works to be dealt with in accordance with trade custom. Immediate efforts are therefore to be made for a resumption of negotiations on the wage rates and conditions of the workmen concerned.

Coal Shipment Facilities.

So far no decision has been come to by the directors of the G.W.R. Company in respect of the curtailment of coal-loading facilities in order to effect necessary economies, but at a private sitting of the Penarth Trades and Labour Council last week-end a further letter from Sir James Milne, general manager of the company, calling upon the workers at Penarth Dock to undergo further voluntary reductions in wages was discussed. The Council decided to call a joint meeting of the union branches next Sunday to consider the company's terms. It may be mentioned that the G.W.R. Company has decided to close the Caerphilly carriage and wagon depôt, and, as a consequence, the Cardiff City Council has appointed a deputation to see the company in order to secure a reversal of its decision. The company has pointed out that in closing the Caerphilly depôt, it was not a question of transferring work to Swindon or elsewhere, but that the work was not available, the company having taken out of maintenance over 4000 wagons and carriages during the past 2½ years.

Current Business.

Operations in coals have been practically at a standstill, owing to the holidays, during which very little fresh inquiry has come along from buyers abroad. The tone of the market remains quiet and easy so far as most descriptions are concerned. Patent fuel continues to be fairly well stemmed, but coke is slow to move off. Pitwood is steadier for prompt supplies.

LAUNCHES AND TRIAL TRIPS.

KEPWICKHALL, steamer; built by Wm. Gray and Co., Ltd., to the order of West Hartlepool Steam Navigation Company, Ltd.; dimensions, 421ft. 9in. by 54ft. 9in. by 27ft. 7in.; to carry cargo. Engines of "Quadropod" type, 20in., 28½in., 41½in., 61in. by 48in. stroke, pressure 260 lb. per square inch; constructed by the builders; trial trip, July 26th.

CONTRACTS.

BEYER, PEACOCK AND CO., Ltd., have received from the Pontardawe Steel and Tin Plate Works (W. Gilbertson and Co., Ltd.), of Pontardawe, Swansea, Glamorganshire, an order for one industrial locomotive of the 0-4-0 type.

JOHN BAKER AND BESSEMER, Ltd., Rotherham, have received an order for wheels and axles for use on the Danish State Railways. These wheels and axles are for use on the new motor coaches in connection with the electrification of the Danish State Railways, for which British contractors recently secured an order for electric train equipment to cost £300,000.

THE D.P. BATTERY COMPANY has in hand at the present time the installation of four large batteries with a combined capacity of over 25,000 ampère-hours. Each of the batteries is to be installed in duplicate bringing the total capacity to over 50,000, ampère-hours. Other work in hand at the present time includes the renewal of two 250-volt D.P. central station batteries and the installation of forty batteries for one of the principal railway companies. In addition, the company has received orders for two 5000 ampère-hour batteries for a telephone exchange in Ireland, 625 cells (ranging in capacity from 10 to nearly 2000 ampère-hours) for a new wireless broadcasting station, and two 500 ampère-hour batteries for installation in the South of England for one of the railway companies.

CATALOGUES.

BOWMAK AND CO., Ltd., 25, Victoria-street, S.W. 1.—Leaflets on the "Kitson" rotary pump.

A. REYROLLE AND CO., Ltd., Hebburn-on-Tyne.—Pamphlet No. 845 on "Power and Control."

WILD-BARFIELD ELECTRIC FURNACES, Ltd., North-road, N. 7.—Particulars of Telcon metals.

JOHN FOWLER AND CO. (LEEDS), Ltd., Leeds.—A leaflet describing the 14/10 concrete mixer.

GREENWOOD AND BATLEY, Ltd., Leeds.—A recent brochure on "Greenbat" electric locomotives.

BUTLER MACHINE TOOL COMPANY, Ltd., Halifax.—Leaflet on the spiral electric planing machine.

B. AND S. MASSEY, Ltd., Openshaw, Manchester.—Catalogue No. 3300 H. of steam and air hammers.

RUSTON-BUCYRUS, Ltd., Lincoln.—A brochure illustrating the firm's complete range of universal excavators.

MAVOR AND COULSON, Ltd., 47, Broad-street, Glasgow.—Leaflet on the "M. & C." scraper chain conveyor.

DOBBIE, MCINNES AND CLYDE, Ltd., 57, Bothwell-street, Glasgow.—A folder of the Teledep boiler water level gauge.

PAYNE AND GRIFFITHS, Ltd., Ladywood-road, Birmingham.—A booklet on pressure gauges of all types and for all purposes.

BRITISH INSULATED CABLES, Ltd., Prescot, Lancs.—Illustrated catalogue of condensers for power, wireless, or telephone.

REDPATH, BROWN AND CO., Ltd., 2, St. Andrew-square, Edinburgh.—Tables of working stresses for the design of steel pillars.

BRITISH ISOTHERMOS COMPANY, Ltd., Thames House, Grosvenor-road, S.W. 1.—First edition of the "Isothermos Technical Bulletin."

NIMROD, Ltd., 4, London Wall-buildings, E.C. 2.—Particulars of the "Century" automatic domestic oil burner and the "Hades" steam jet burner for boilers.

WESTINGHOUSE BRAKE AND SAXBY SIGNAL COMPANY, Ltd., 82, York-road, N. 1.—A loose-leaf catalogue of appliances for mechanical and power-operated signalling.

DAVID BROWN AND SONS (HUDDERSFIELD), Ltd., Park Works, Lockwood, Huddersfield.—Booklet on "Taurus Bronze Castings," giving full particulars of the chemical analysis and physical properties of the special bronzes.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
(1) Native	16/6 to 20/–
(1) Spanish	17/– to 22/6
N.E. Coast—	
Native	18/– to 21/–
Foreign (c.i.f.)	14/9

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	3 8 6	—
No. 1 Foundry	3 12 0	—
No. 3 Foundry	3 9 6	—
N.E. Coast—		
Hematite Mixed Nos.	3 1 0	3 1 0
No. 1	3 1 6	3 1 6
Cleveland—		
No. 1	3 1 0	3 1 0
Siliceous Iron	3 1 0	3 1 0
No. 3 G.M.B.	2 18 6	2 18 6
No. 4 Foundry	2 17 6	2 17 6
No. 4 Forge	2 17 0	2 17 0
Mottled	2 16 6	2 16 6
White	2 16 6	2 16 6
Midlands—		
(e) Staffs.—	(*Delivered to Station*).	
All-mine (Cold Blast)	—	—
North Staffs. Forge	3 1 0	—
„ „ Foundry	3 6 0	—
(e) Northampton—		
Foundry No. 3	3 2 6	—
Forge	2 17 6	—
(e) Derbyshire—		
No. 3 Foundry	3 6 0	—
Forge	3 1 0	—
(3) Lincolnshire—		
No. 3 Foundry	—	—
No. 4 Forge	—	—
Basic	—	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	3 15 6 (*a*) / 4 0 6 (*b*) / 4 5 6 (*c*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	9 15 0	9 5 0
Best	—	—
N.E. Coast—		
Iron Rivets	11 5 0	—
Common Bars	9 5 0	—
Best Bars	10 5 0	—
Double Best Bars	10 15 0	—
Treble Best Bars	11 5 0	—
Lancs.—		
Crown Bars	9 15 0	—
Best Bars	10 5 0	—
Hoops	12 0 0	—
S. Yorks.—		
Crown Bars	9 15 0	—
Best Bars	10 15 0	—
Hoops	12 0 0	—
Midlands—		
Crown Bars	9 0 0 to 9 15 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	8 0 0 to 8 10 0	—
Gas Tube Strip	10 10 0	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates (Marine)	9 0 0	8 10 0
„ „ (Land)	—	—
Ship Plates, ½in. and up	8 15 0	7 15 0
Sections	8 7 6	7 7 6
Steel Sheets, ½in.	7 15 0	7 15 0
Sheets (Gal. Cor. 24 B.G.)	11 0 0	10 5 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	8 15 0	7 15 0
Angles	8 7 6	7 7 6
Boiler Plates (Marine)	10 10 0	—
„ „ (Land)	10 0 0	—
Joists	8 15 0	7 7 6
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5s.
Hard Billets	7 2 6	—
Soft Billets	5 10 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 5 0	—
Light Rails	8 10 0 to 8 15 0	—
Billets	6 10 0 to 9 0 0	—
Manchester—		
Bars (Round)	9 7 6	—
„ (Small Round)	6 15 0 to 7 0 0	—
Hoops (Baling)	10 0 0	9 15 0
„ (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
„ (Lancs. Boiler)	8 10 0 to 8 12 6	—
Sheffield—		
Siemens Acid Billets	9 2 6 (basis)	—
Hard Basic	8 2 6 and 8 12 6	—
Intermediate Basic	6 12 6 and 7 2 6	—
Soft Basic	5 15 0	—
Hoops	9 10 0 to 9 15 0	—
Soft Wire Rods	7 10 0	—
Midlands—		
Small Rolled Bars (all British)	7 5 0 to 7 15 0	—
Small Re-rolled Bars	6 7 6 to 6 10 0	—
Billets and Sheet Bars	4 17 6 to 5 7 6	—
Galv. Sheets, f.o.b. L'pool	9 5 0 to 9 7 6	—
(2) Staffordshire Hoops	9 10 0	—
(*d*) Angles	8 7 6	—
(*d*) Joists	8 15 0	—
(*d*) Tees	9 7 6	—
(*d*) Bridge and Tank Plates	8 17 6	—
Boiler Plates	8 7 6 to 8 10 0	—

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14 f.o.b.	15/0 to 15/6
Block Tin (cash)	125 12 6
„ (three months)	127 5 0
Copper (cash)	25 0 0
„ (three months)	24 11 3
Spanish Lead (cash)	9 12 6
„ „ (three months)	9 15 0
Spelter (cash)	11 15 0
„ (three months)	11 16 3
Manchester—	
Copper, Best Selected Ingots	31 10 0
„ Electrolytic	32 10 0
„ Strong Sheets	57 0 0
„ Tubes (Basis Price), lb.	0 0 9½
Brass Tubes (Basis Price), lb.	0 0 8½
„ Condenser, lb.	0 0 11
Lead, English	12 7 6
„ Foreign	10 17 6
Spelter	12 10 0
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

Tungsten Metal Powder	2/– per lb.	
Ferro Tungsten	1/9 per lb.	
	Per Ton.	Per Unit.
Ferro Chrome, 4 p.c to 6 p.c. carbon	£25 0 0	8/–
„ „ 6 p.c. to 8 p.c.	£24 10 0	7/6
„ „ 8 p.c. to 10 p.c.	£23 15 0	7/–
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£37 0 0	11/–
„ „ „ 1 p.c. carbon	£47 0 0	14/–
„ „ „ 0·70 p.c. carbon	£48 0 0	16/–
„ „ „ carbon free	1/1 per lb.	
Metallic Chromium	2/9 per lb.	
Ferro Mangapese (per ton)	£11 0 0 for home	
„ „ „	£11 10 0 for export	
„ Silicon, 45 p.c. to 50 p.c.	£13 10 0 scale 5/– per unit	
„ „ 75 p.c.	£19 0 0 scale 6/– per unit	
„ Vanadium	12/6 per lb.	
„ Molybdenum	6/3 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£250 to £255	
Ferro Cobalt	8/– per lb.	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	13/–
„ „ Ell	14/–
„ „ Splint	13/9 to 14/9
„ „ Trebles	12/6
„ „ Doubles	10/– to 10/6
„ „ Singles	9/6
Ayrshire—	
(f.o.b. Ports)—Steam	11/6
„ „ Jewel	16/6
„ „ Trebles	13/–
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	10/3 to 12/6
Screened Navigation	16/6
Trebles	13/– to 15/6
Doubles	10/3 to 10/6
Singles	9/9
Lothians—	
(f.o.b. Leith)—Best Steam	11/– to 11/6
Secondary Steam	10/6
Trebles	13/6
Doubles	11/– to 11/3
Singles	9/– to 9/6

(8) N.W. Coast— ENGLAND.

Steams	21/9
Household	32/6 to 51/8
Coke	19/– to 22/6
Northumberland—	
Best Steams	13/6
Second Steams	12/3 to 12/6
Steam Smalls	8/6
Unscreened	12/6 to 13/–
Household	27/– to 39/–
Durham—	
Best Gas	14/6
Second	13/3 to 13/6
Household	25/– to 37/–
Foundry Coke	24/–

Sheffield— Inland.	
Best Hand-picked Branch	25/– to 26/– —
South Yorkshire Best	20/– to 21/– —
Derbyshire Best House	20/– to 21/– —
Derbyshire Best Brights	17/– to 18/– —
Screened House Coal	15/– to 16/– —
Kitchen Coal	14/– to 15/6 —
Best Screened Nuts	15/– to 16/– —
Small Screened Nuts	13/6 to 15/6 —
Yorkshire Hards	16/– to 18/– —
Derbyshire Hards	16/– to 18/– —
Rough Slacks	8/6 to 9/6 —
Nutty Slacks	7/– to 8/6 —
Blast-furnace Coke (Inland)	10/– on rail at ovens
Furnace and Foundry Coke (Export), f.o.b., 13/6 to 15/–	

(9) SOUTH WALES.

Cardiff— Steam Coals:	
Best Smokeless Large	19/6 to 19/9
Second Smokeless Large	18/9 to 19/6
Best Dry Large	19/– to 19/6
Ordinary Dry Large	17/9 to 18/3
Best Black Vein Large	18/3 to 18/6
Western Valley Large	17/9 to 18/–
Best Eastern Valley Large	17/7½ to 17/9
Ordinary Eastern Valley Large	17/3 to 17/6
Best Steam Smalls	13/– to 13/6
Ordinary Smalls	11/– to 13/–
Washed Nuts	19/– to 25/–
No. 3 Rhondda Large	19/6 to 19/9
„ „ Smalls	15/– to 16/–
No. 2 „ Large	17/– to 17/3
„ „ Through	15/6 to 16/–
„ „ Smalls	14/– to 14/3
Foundry Coke (Export)	22/6 to 36/6
Furnace Coke (Export)	17/– to 18/–
Patent Fuel	20/–
Pitwood (ex ship)	22/– to 23/–
Swansea— Anthracite Coals:	
Best Big Vein Large	36/– to 38/6
Seconds	27/– to 32/6
Red Vein	22/6 to 27/6
Machine-made Cobbles	41/6 to 48/6
Nuts	40/– to 48/6
Beans	28/6 to 32/6
Peas	19/6 to 21/–
Breaker Duff	8/6 to 9/6
Rubbly Culm	11/– to 11/6
Steam Coals:	
Large	20/– to 20/6
Seconds	18/– to 20/–
Smalls	11/6 to 13/–
Cargo Through	16/– to 17/6

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham. (*d*) Rebate: Joists (minimum), 22/6: Ordinary Ship, Bridge, and Tank Plates and Sections, 15/– if home consumers confine purchases from associated British Steel Makers. (*e*) Delivered Black Country Stations.

French Engineering Notes.

(From our own Correspondent in Paris.)

European Federation of Engineers.

FOLLOWING upon the inaugural lunch in Paris recently of a group of engineers under the presidency of Monsieur Yves Le Trocquer, former Minister of Public Works, with the object of initiating a movement for the creation of a European Federation of Engineers, the secretary of the Chambre Syndicale des Ingénieurs, Monsieur A. Guiselin, who is responsible for the idea of this new organisation, has explained its aims more fully. All the existing engineers' associations are of a more or less professional character, and do not take into account the influence which the profession ought to exercise upon the world's economic development. In all the discussions upon industrial and economic questions the views of employers and workers are presented, and it is often difficult to reconcile them, while they also intervene in the larger issues at Geneva and elsewhere when economic problems affecting world prosperity are debated. Yet no voice should have a greater influence than that of the engineer. He stands between the employer and the worker, and his close association with them enables him to understand perfectly the aims and sentiments of each, while his training is precisely of that character which qualifies him to find solutions of conflicting interests that are technical and social, and can only be solved in the light of national and even world interest. It is argued that as the engineer is a man of broad vision, and is accustomed to work out problems with a logical mind and a close grasp of detail, he is better able than anyone to direct effort in the way of economic organisation. Besides, it is hardly conceivable that the vast schemes of national and international public works can be put in hand with any chance of their proving successful and self-supporting unless they are prepared by technicians instead of being pushed forward, as is often the case, by particular or local interests. The problems confronting economists are industrial and technical, since they arise partly out of new production methods and more largely out of a disorganised adjustment of supply and demand. This is a field in which engineers should be afforded a wide scope for their organising ability, but they will never be able to do so until they are themselves organised internationally. There are obvious difficulties in the way, because the profession must find out, first of all, how the problem is approached by engineers in different countries, and then how to bring them together in the hope of evolving a definite international policy of intervention in all social, technical, and economic matters affecting world prosperity. The French have begun by forming a group which will develop into a national club of engineers, of which meetings will be held to discuss matters affecting production. It is intended to give to these meetings an informal character at which everyone interested in these problems, as well as foreign engineers, will be welcomed.

The Saint-Nazaire Dry Dock.

When the order for the new big liner was given to the Penhoët shipyard on the understanding that arrangements should be made at once for the construction of an entrance to the port of Saint-Nazaire of sufficient dimensions to allow of the liner leaving the yard, and of its serving also as a dry dock, work was started on the lock in April, 1930, and on Sunday last it was officially inaugurated. The lock has a length of 600 m. and its width is 53 m. at the bottom and 150 m. at the top. It provides a depth of water of 14 m. The weight of each of the two gates is 1500 tons. The lock can be emptied in a few hours to serve as a dry dock for the new liner. It is stated that the ship will be launched during the autumn.

Water Sterilisation.

A plant for sterilising water on the principle introduced by Monsieur Philippe Bunau-Varilla, who found that a minute dose of chlorine in a mass of water in active movement was equally as effective as the bigger doses usually employed, has been installed at the Ivry works in Paris, and another will be put down at Saint-Maur. It was during the war that Monsieur Bunau-Varilla, while in charge of the water supply at Verdun, tried to avoid the disagreeable taste given by large doses of chlorine, and by reducing them reached a point where a very minute quantity of chlorine in churned water destroyed completely all dangerous bacilli. The system has come into extensive employment in France during recent years, and is now being adopted by the Paris Municipality, which has to deal with a considerable volume of river water. The quantity of water supplied to Paris daily is about 600 million litres of spring and river water, the latter filtered and both sterilised with chlorine, and 700 million litres for municipal services from the Seine, Marne, and Ourcq, which is neither filtered nor sterilised. Owing to the possibility of people drinking this water, it is henceforth to be "verdunised," so called because the system was first employed at Verdun during the war.

Railway Electrification.

That part of the Orleans Railway which is already electrified is supplied with current from the hydro-electric power station at Eguzon through the transformer station at Chevilly, near Paris, as well as from the Paris thermal electric supply system. The extension of the electrified sections from Orleans to Tours and from Vierzon to Brive has made it necessary to proceed actively with the second supply system from the Massif Central, and, in addition to the Chavanon and Celette stations, another power station is to be constructed on the Dordogne at Marèges, where there will be four groups of turbo-alternators, each of 37,500 kVA. The line carrying 220,000 volts will be connected up with the main line from Eguzon to Chevilly. The Orleans Company is developing electrification on sections of the railway on which the traffic is heavy, and as it produces its own current from hydro-electric plants, and has a surplus for sale, the running of such lines is found to be economical. The section between Orleans and Tours will be put into service next year, and the line from Vierzon to Brive is expected to be completed early in 1935.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

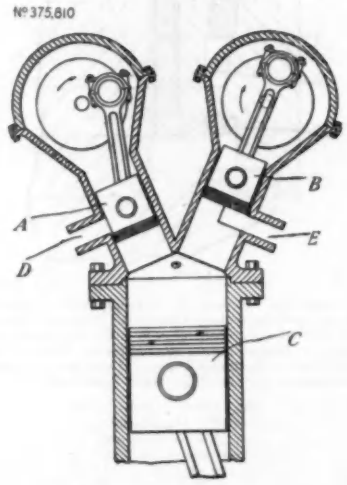
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

375,810. March 31st, 1931.—VALVE GEAR AND VALVES FOR INTERNAL COMBUSTION ENGINES, R. H. Cox, 13, Lorn-road, Brixton, London, S.W. 9.

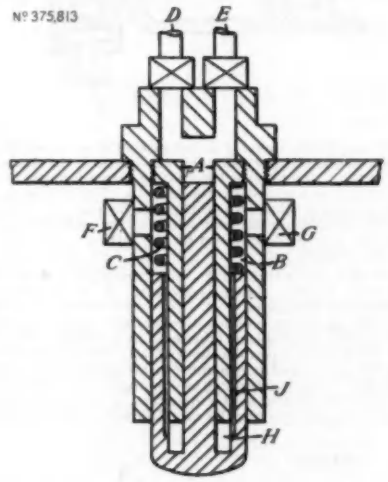
The inventor uses two piston valves A and B to control the exhaust and inlet to the working cylinder C. These



valves work, as is obvious from the drawing, by opening and closing the ports D and E. It would seem, however, that a more important part of the invention lies in the stirring up of the combustible mixture by the relative movement of the several pistons.—*June 30th*, 1932.

375,813. January 1st, 1931.—FUEL PUMPS FOR OIL ENGINES, E. A. Franks, 5, Caegwyn-road, Whitchurch, Glamorgan; and Franks Motors, Ltd., 9, Western Mail Chambers, Cardiff.

This fuel oil pump is combined with a lubricating oil pump. It has two concentric barrels, one A, for the fuel and the other, annular, one B for the lubricating oil. The plunger is correspondingly formed and is forced upward, by mechanism not

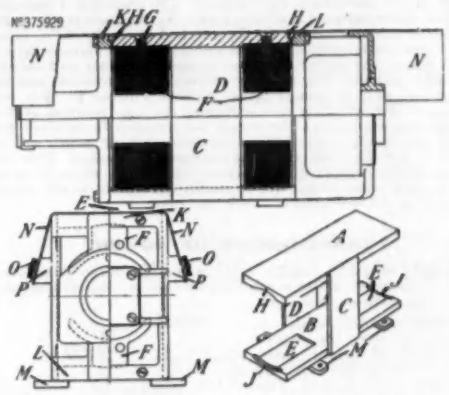


shown, against the resistance of the spring C. The inlet and outlet fuel valves are shown at D and E respectively, and the oil valves at F and G. The lubricating oil finds its way into the space H through the grooves J. It will be seen that on the delivery stroke the lubricating oil pressure mounts as does that of the fuel oil, and by so proportioning the parts that the lubricating pressure is always slightly in excess of that of the fuel, leakage of the fuel back into the lubricating system is prevented.—*July 1st*, 1932.

DYNAMOS AND MOTORS.

375,929. April 28th, 1931.—MOTOR GENERATORS AND LIKE DYNAMO-ELECTRIC MACHINERY, Frederick Newton, of Alfreton-road, Derby.

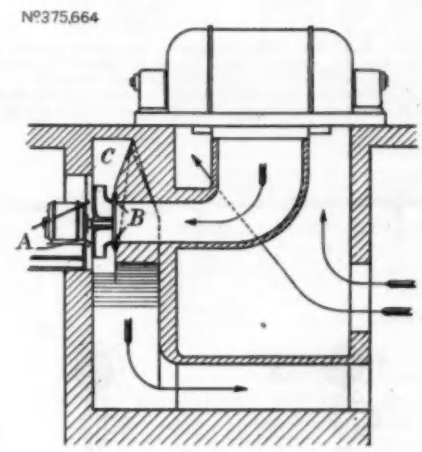
This invention relates to dynamo-electric machines, such as motor generators, having two armatures in series in a single magnetic circuit completed by pairs of yoke members, every yoke member carrying one pole of the field of each armature, so that each armature and field forms the principal part of the return circuit for the other. According to the invention the magnetic circuit is shunted between the armature locations. The shunt will carry any excess of the flux of either machine over that of the other, irrespective of the direction of flow of such excess, and its section is not more than sufficient for that purpose. The magnet frame may be constructed of strips of standard rolled steel section lying parallel with the machine shaft, and united by distance pieces which may also be of rolled steel and welded in position to form the magnetic shunt above mentioned. Such a construction provides a frame using the minimum of material with a short magnetic circuit, and yields a compact, well-ventilated and accessible machine. The magnet frame illustrated comprises two parallel rolled steel strips A B of flat rectangular section joined centrally by two flat steel distance pieces C D welded to them. Shallow recesses E are turned in the strips A B about a central axis in which the shaft of the machine is subsequently borne, to form seatings for pole pieces F turned on both the inner and outer faces and each held in place by a single screw G. Short deeper recesses H J are turned in the ends of the strips A B to receive end castings K L, which are turned to fit and carry the shaft bearings and may also support



brush rockers. The machine stands on feet M welded on the lower strip B, by which it may be bolted to a support. The machine is protected from drippings, without enclosing it, by a sheet metal cover N extending the whole length of the machine and bent laterally over the upper strip A to form sloping sides and secured by nuts O in studs projecting from lugs P welded to the distance pieces C D. It will be understood that a four-pole frame may be similarly built up from four longitudinal yoke strips.—*July 7th*, 1932.

375,664. October 26th, 1931.—THE VENTILATION OF DYNAMO-ELECTRIC MACHINES, Aktiengesellschaft Brown, Boveri et Cie., of Baden, Switzerland.

In large electrical machines separate fans are frequently employed for ventilating purposes, and the object of this invention is to reduce the cost of the fans. The rotor of the fan is

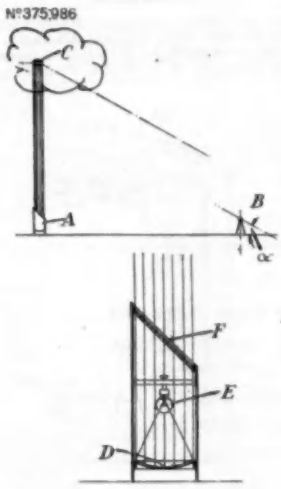


overhung on the end of the motor shaft and is sealed at A and B with respect to the surrounding masonry. The discharge spiral C and the intake and discharge ducts are formed in the foundation, and the scheme is claimed considerably to reduce the initial cost.—*June 30th*, 1932.

MEASURING AND TESTING INSTRUMENTS.

375,986. June 18th, 1931.—MEASURING THE ALTITUDE OF CLOUDS, Julius Pintsch, Aktiengesellschaft, Andreasstrasse 71–73, Berlin, O. 27, Germany.

This invention relates to means for measuring the altitude of clouds in connection with aerial navigation at night. The searchlight or projection apparatus in conjunction with a measuring device, as heretofore used for the purpose in question, have



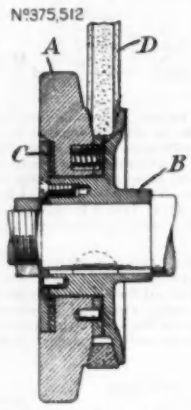
suffered from certain disadvantages in so far as the spot of light projected on to the clouds is usually so weak and inexact that in many cases measurement is quite impossible. According to the invention, the projection apparatus comprises a casing having a flat hollow reflector and a lamp furnished with a filament of particular contour; for example, annular, or in the form of crossed lines so as to permit of the projection of an image of

corresponding sharply defined contour on the clouds. To permit of better penetration of the light in foggy or misty weather the lamp may be overloaded by excess voltage for a brief space of time. The projector A is situated at a fixed distance from the measuring instrument B. The instrument permits of measurement of the angle which is formed by a line connecting the instrument with the spot of light C on the clouds and the horizontal. With this angle α in conjunction with the base line there is no difficulty in calculating the altitude. The projector A includes a flat hollow reflector D of long focus. In the focal point of the reflector there is situated the lamp E, and the latter is furnished with an annular, crossed, or other suitably shaped filament which will enable the projection of an image of distinct and clearly defined contour. The reflector and lamp are protected against dust and rain by means of an inclined window F. For the purpose of controlling and adjusting the zero position of the measuring instrument there may be provided in or upon the projector casing a suitably conspicuous marking, which will be visible from the point where the instrument is located. This, for example, may consist of an aperture in the casing, through which aperture a point of light will be readily discernible to the person posted at the instrument.—*July 7th*, 1932.

TRANSMISSION OF POWER.

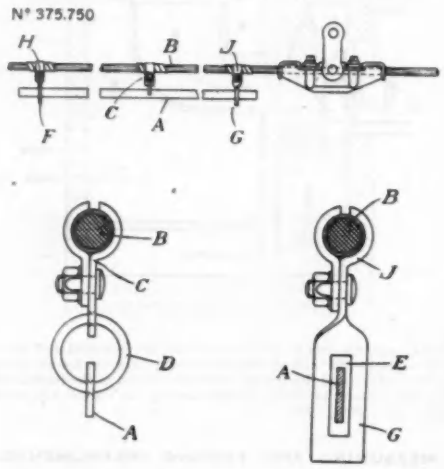
375,512. May 30th, 1932.—A Means of Reducing Torsional Vibration in Rotating Shafts, General Motors Corporation, Detroit, Michigan.

The inventor aims at damping out the cyclic vibrations of a crank shaft, which result in it having several critical speeds. This is effected by using a secondary fly-wheel A, which is free to rotate on a bush B on the shaft. The wheel is, however, driven by frictional contact against a washer C. The force necessary to press the wheel against the washer is provided by the wedging action of the fan belt D. As the speed of the engine is raised the resistance of the fan increases, the tension in the belt also increases, and as a consequence the fly-wheel is wedged tighter against the friction washer, so that it becomes more effective.—*June 30th*, 1932.



375,750. May 2nd, 1932.—Damping the Oscillations of Electrical Conductors, Vereinigte Aluminium-Werke Aktiengesellschaft, of Lautawerk/Lausitz, Germany.

This specification describes a device for damping the oscillations of overhead conductors. The device consists of a balance

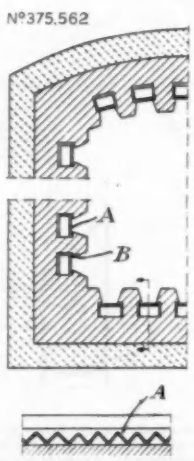


beam A which is clamped to the conductor B by means of a clamp C attached to a ring D. The ends of the beam are movable in slots E of the guides F G, which are secured to the conductor by clips H J. Experience is said to have shown that it is possible to suppress oscillations completely by means of this simple and inexpensive device.—*June 30th*, 1932.

FURNACES.

375,562. July 7th, 1931.—Electric Resistance Furnaces, Allmänna Svenska Elektriska Aktiebolaget, of Västeras, Sweden, and Lennart Högel, of Herrgårdsgatan 8, Västeras.

The heating elements of an electric furnace constructed in

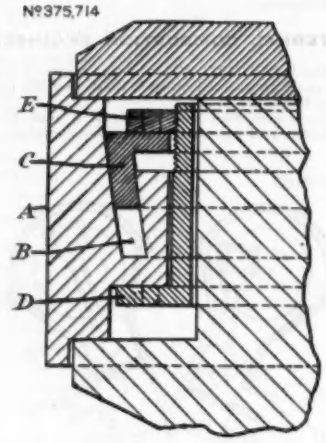


accordance with this invention consist of corrugated bands A mounted so that one broadside of each band faces the interior of the furnace. The bands are held in position by projections B formed on the brickwork. In the case illustrated elements are placed on all the walls of the furnace, but this is not essential.—*June 30th*, 1932.

MISCELLANEOUS.

375,714. December 29th, 1931.—Piston Rings, A. Cross, W. F. Brown, and F. Bedford, 2, St. Mary Axe, London, E.C. 3.

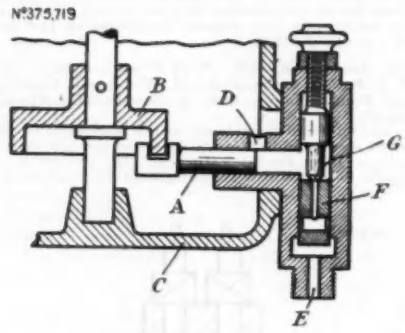
The object of this invention is to provide a piston ring which will retain a true circular form regardless of how much it is



expanded and also to prevent it from either expanding or collapsing beyond the required amount. The split ring is shown at A and is formed with a conical groove B. This groove engages a solid ring C of corresponding conical form. The two rings are pressed together by the flanged sleeve D and nut E to determine the outside diameter of the ring.—*June 30th*, 1932.

375,719. January 14th, 1932.—Lubricating Pumps, R. von Kalmann, Luegallee 68, Düsseldorf-Oberkassel, Germany.

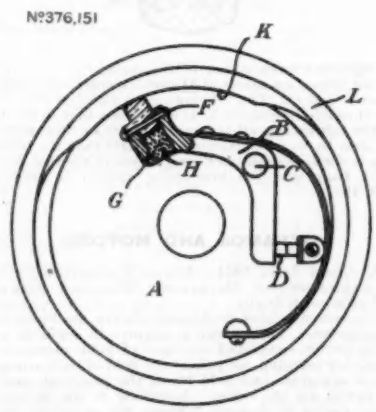
The lubricating pump A is reciprocated by the excentric B and draws its supply from the sump C through the port D. It may be desired to vary the amount of oil forced forward to the outlet E at each stroke of the pump. This is effected by the floating piston F, which is ported to pass the delivery. Above



the floating piston there is an adjustable stop G, which, incidentally, closes the port through the piston. On the suction stroke of the pump plunger the floating piston follows its movement until it is arrested by the stop G. The clearance space then remaining is filled with oil through the port D. This oil is, of course, expelled on the next stroke of the pump plunger and its amount may be determined by the setting of the stop G.—*June 30th*, 1932.

376,151. November 12th, 1931.—Electric Contact Breakers, Robert Bosch Aktiengesellschaft, of 4, Militärstrasse, Stuttgart, Germany.

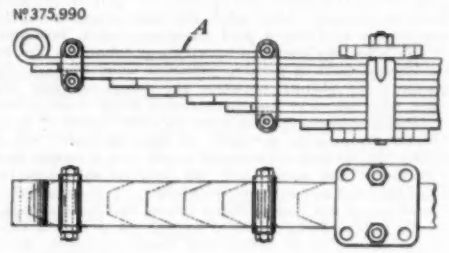
Hitherto, in rotary contact breakers the working surface of the interrupter cam has been lubricated by felt strips sliding on it, which are saturated periodically with oil; alternatively a lubricating felt is provided in a chamber on the interrupter cam which supplies the lubrication through an opening in the working surface of the cam. According to the invention, a chamber is provided in the interrupter lever or the cam follower carried thereby for



the reception of lubricant. On the rotating base-plate A of an interrupter the rocking lever B is mounted on a pin C secured to the base-plate. At one end of the lever B is the rocking contact D. At the other end the fibre cam follower is fastened by a pin F. The hole G in the rocking lever for receiving the cam follower passes through the lever, so that on the inner side of the cam follower a chamber H is formed, in which the lubricant for the cam follower is provided. The rocking lever B is operated by the cam K, provided on the stationary casing L of the interrupter. As the cam follower is made of fibrous material, it absorbs the lubricant in the chamber H, so that the working surface of the cam K is also constantly provided with grease. When the fibrous cam or the fibrous cam follower is saturated with grease, it loses its hygroscopic properties. In rotary interrupters, as in the present example of construction, the grease chamber H can remain open on the side facing the axis of rotation, as the lubricant is thrown against the cam follower by the centrifugal force. In interrupters with rotary cams and a rocking lever mounted on a stationary base-plate, the grease chamber is preferably closed.—*July 7th*, 1932.

375,990. June 20th, 1931.—Laminated Springs, T. Turton and Sons, Ltd., Sheaf Works, Maltravers-street, Sheffield, and H. Walker.

This invention relates to laminated springs. In practice, it is found that there is a tendency for the top plate or leaf to move away from the other plates of the spring, which is one of the main reasons for so many breakages and failures of this top plate. This fault occurs particularly upon road vehicles, the springs of which are subject in many cases to undue shocks and overloads, and which have very great stresses to contend with in regard to braking and cornering. Another disadvantage is



the tendency of the top plate to move away from the other plates so that the springs tend to set and lose their shape owing to lack of support to the top plate. According to the invention, a laminated spring of usual form is provided with a pair of check plates A mounted one at either end of the spring above the top plate, for the purpose of supporting the plate in working and minimising the risk of it breaking. These check plates have eyes formed in them at either end, and are coupled to shackle plates by bolts and nuts to two of the plates of the spring which have similar eyes formed to take the bolts and shackles.—*July 7th*, 1932.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Tuesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

FRIDAY, AUGUST 19TH, TO MONDAY, SEPTEMBER 19TH.

Institution of Mechanical Engineers.—Summer visit to Canada.

SATURDAY, AUGUST 20TH.

Institution of Municipal and County Engineers.—North Wales District meeting at Penmaenmawr. Meet at Penmaenbach works, Penmaenmawr. 2.15 p.m.

WEDNESDAY, AUGUST 31ST, TO WEDNESDAY, SEPTEMBER 7TH.

British Association for the Advancement of Science.—Annual meeting at York. President, Sir J. Alfred Ewing, F.R.S. Particulars may be obtained on application to the secretary, British Association, or to the hon. local secretaries, British Association, The Guildhall, York.

SATURDAY, SEPTEMBER 10TH.

Institution of Municipal and County Engineers.—Eastern District meeting to be held at Great Yarmouth. Assemble at Town Hall, Great Yarmouth, 10.30 a.m.

MONDAY, SEPTEMBER 12TH.

Institute of Metals.—At the Institution of Mechanical Engineers, Storey's-gate, Westminster, S.W. 1. Annual autumn lecture, "Corrosion Fatigue in Metals," by Dr. H. J. Gough. 8 p.m.

MONDAY TO THURSDAY, SEPTEMBER 12TH TO 15TH.

Iron and Steel Institute and Institute of Metals.—Joint autumn meeting in London. For programme see page 119.

TUESDAY TO SATURDAY, SEPTEMBER 13TH TO 17TH.

International Foundry Congress.—Paris.

SATURDAY, SEPTEMBER 24TH.

All-British Exhibition.—Copenhagen, Denmark. Opening.

Eleventh Conference of the Institut International de Documentation.—The eleventh conference of the Institut International de Documentation (formerly de Bibliographie) will be held this year at Frankfurt-am-Main, from August 30th to September 3rd. The conference is open to all persons interested in the various aspects of documentation, i.e., the collection, arrangement, filing, and indexing of graphic records. As in previous years, an attractive programme of papers has been arranged for presentation and discussion during the mornings, whilst the afternoons and evenings will be devoted to visits of inspection and recreation. The latter include visits to Darmstadt and Mains, where State and municipal libraries will be inspected. The conference fee of 12 R.M. includes all excursions. A special exhibition of technical appliances for library purposes has been organised in a room of the conference building during the meeting. The programme of papers to be presented is not yet available, but copies of all papers will be distributed to members of the conference before the opening session. Full particulars regarding hotels and accommodation and further details of the conference may be obtained from the Organising Secretary, Dr. Schürmeyer, Direktor der Bibliothek für Kunst und Technik, Frankfurt-am-Main, or from the Secretary, British Society for International Bibliography, Science Library, South Kensington, S.W. 7.